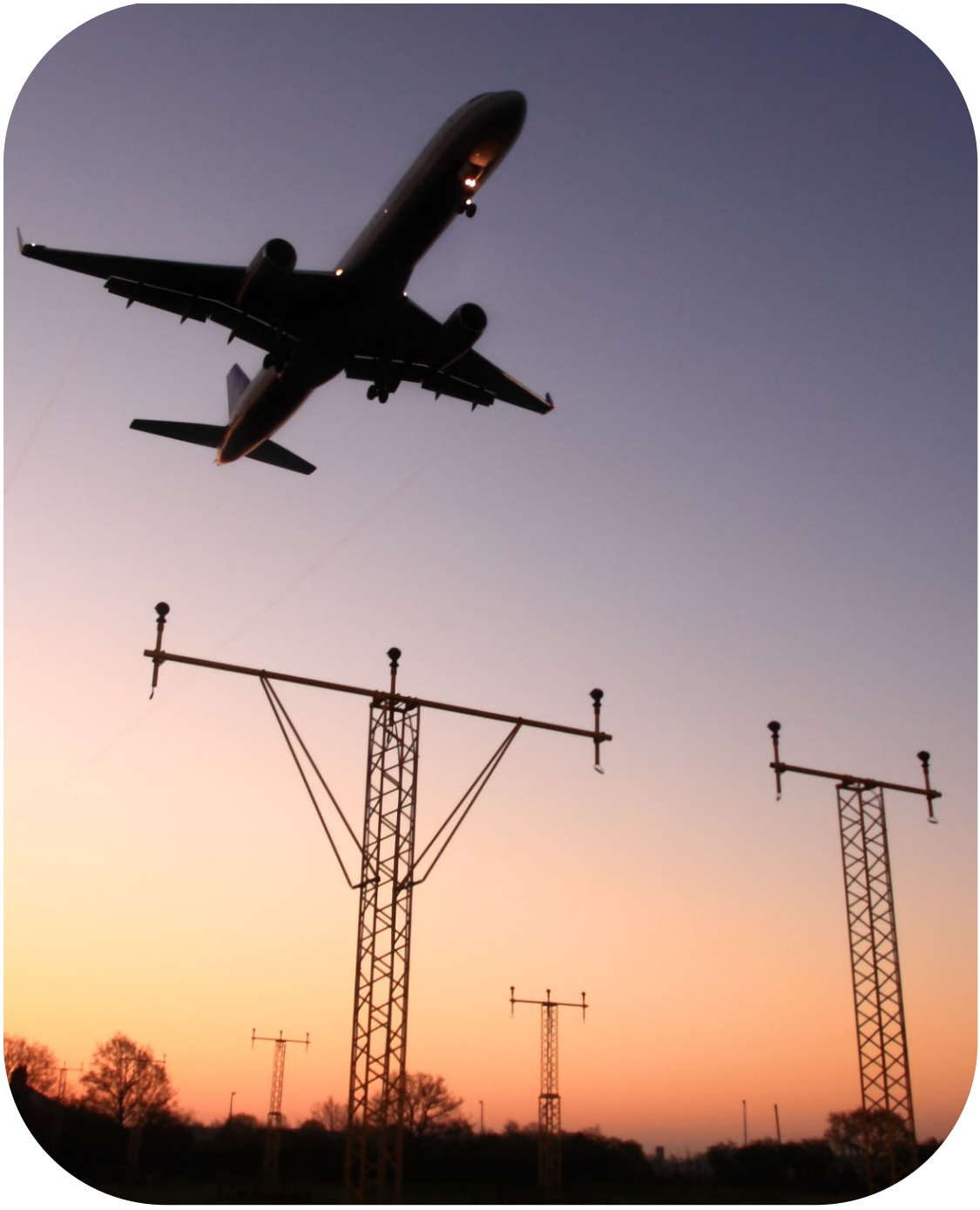


FRANGIBLE LATTICE APPROACH MASTS
INSTALLATION MANUAL

20.02.2023
Revision 2.0

exel
COMPOSITES

CONTENTS

1. GENERAL

1.1 SYMBOLS USED IN THIS MANUAL

Specific symbols are used in this manual to attract readers' attention to information of special importance. These symbols, their reference and explanations are presented in the table below.

Symbol	Referent	Explanation
	INFO	A useful hint to facilitate installation.
	NOTE	In case of incorrect action, the structures are in danger of being broken. When performing this action, please exercise extreme caution. Note related to the matter.
	DANGER	In case of incorrect action, fitters or persons in the proximity are in danger of accident. Please exercise extreme caution when performing this action.
	REFERENCE	Further information about the subject elsewhere in the manual.

1.2 REQUIREMENTS OF ICAO

According to the requirements of ICAO (International Civil Aviation Organisation) frangible safety approach light masts shall be used in all installations. Below is an extract from Aerodrome Design Manual Part 6, Frangibility, First Edition – 2006.

"Chapter 1 INTRODUCTION
1.3 OBSTACLES TO BE MADE FRANGIBLE

1.3.2 Annex 14 — Aerodormes, Volume I — Aerodorme Design and Operations, Chapter 5, specifies that elevated approach lights and their supporting structures should be frangible except that, in that portion of the approach lighting system beyond 300 m from the threshold:

a) where the height of the supporting structure exceeds 12 m, the frangibility requirements should apply to the top of 12 m only; and

b) where a supporting structure is surrounded by non-frangible objects, only that part of the structure that extends above the surrounding objects shall be frangible.

Chapter 5 TESTING FOR FRANGIBILITY
5.1 GENERAL

5.1.2 The frangibility of any aid should always be proven before the aid is considered for installation. High-speed, full-scale testing is a proven method for verification of frangibility. Results of the numerical simulation show this approach to be capable of demonstrating frangibility. Hoewver, as for any numerical simulation methods, the model and simulation approach used must be validated for this purpose by comparison with representative test data. Numerica simulation methods are discussed in Chapter 6.

5.1.4 Static tests, as opposed to dynamic tests , are considered adequate for verification of frangibility of visual aids of low mass having an overall height equal to or less than 1.2 m, such as elevated runway and taxiway lights, taxiing guidance signs and visual approach indicator systems.

5.1.5 Dynamic test are recommended for verification of frangibility of navigational aids having an overall height in excess of 1.2 m and located in positions where they are likely to be impacted by an aircraft in flight. Such aids are approach lighting towers, wind direction indicators, transmissometers, ILS localizer and glide path antennas and MLS approach azimuth and elevation equipment. ILS glide path antenna and the MLS aaproach azimuth and elevation equipment provide a unique situation due to their size and mass of the instrument and support structure. While frangibility requirements should be applied to this equipment in general, these requirements may be too restrictive for such large structures."

(Aerodrome Design Manual Part 6, Frangibility; First Edition — 2006: International Civil Aviation Organisation, Doc 9157 AN/901.)According to the requirements of ICAO (International Civil Aviation Organisation) frangible safety approach light masts shall be used in all new installations. Below is an extract from International Standards and Recommended practices, Annex 14 Vol.1, seventh edition July 2016, § 5.3.1.4"

1.3 MAST FAMILY OF EXEL COMPOSITES PLC

Exel Composites Plc has accepted the challenge of ICAO requirements by designing a light, frangible, approach light mast family based on composite materials. The Exel mast has passed a full-scale impact test as a proof of meeting the requirements of ICAO. In Exel masts, frangibility is a unique built-in feature and no break-away points at regular intervals used by other manufacturers are needed. If case of a collision, the mast will break at the point of impact, and there is no danger of the broken pieces of the mast wrapping around the wing of the aircraft.

Due to its design and materials, an Exel mast is light but at the same time very stiff and strong and can thusly well withstand wind loads and jet blast loads caused by aircraft jet engines. In case of a side impact, however, the mast will break down safely into small pieces.

Exel masts are in practice maintenance-free and the composite materials used in them resist fatigue and corrosion. The masts will maintain their physical properties regardless of the weather and temperature. They can be safely used in maritime or other climate conditions causing corrosion.

Exel-masts are painted with visible aviation yellow color, and therefor they do not need to be marked separately for visibility. The chosen materials make the masts transparent to electromagnetic signals. Exel masts do not distort ILS signals and as a result, the need for calibration of ILS antenna system is decreased. The shape and dimensions of Exel masts will not be deformed when the masts are lowered down for light maintenance, and consequently, re-aligning of lights is not necessary.

1.4 EXEL LATTICE MASTS

Exel lattice masts have a modular construction. In the centre hinged masts the lower section consists of a module of 500 mm, and the top section of a module of 400 mm. The mast sections are joined together with a centre hinge. The cross bar tube is mounted on top of the 400 mm module. The minimum height of a centre hinged mast is 5,5 m and the maximum height is 15,5 m. The masts with height exceeding 12,5 m are fitted on steel posts.

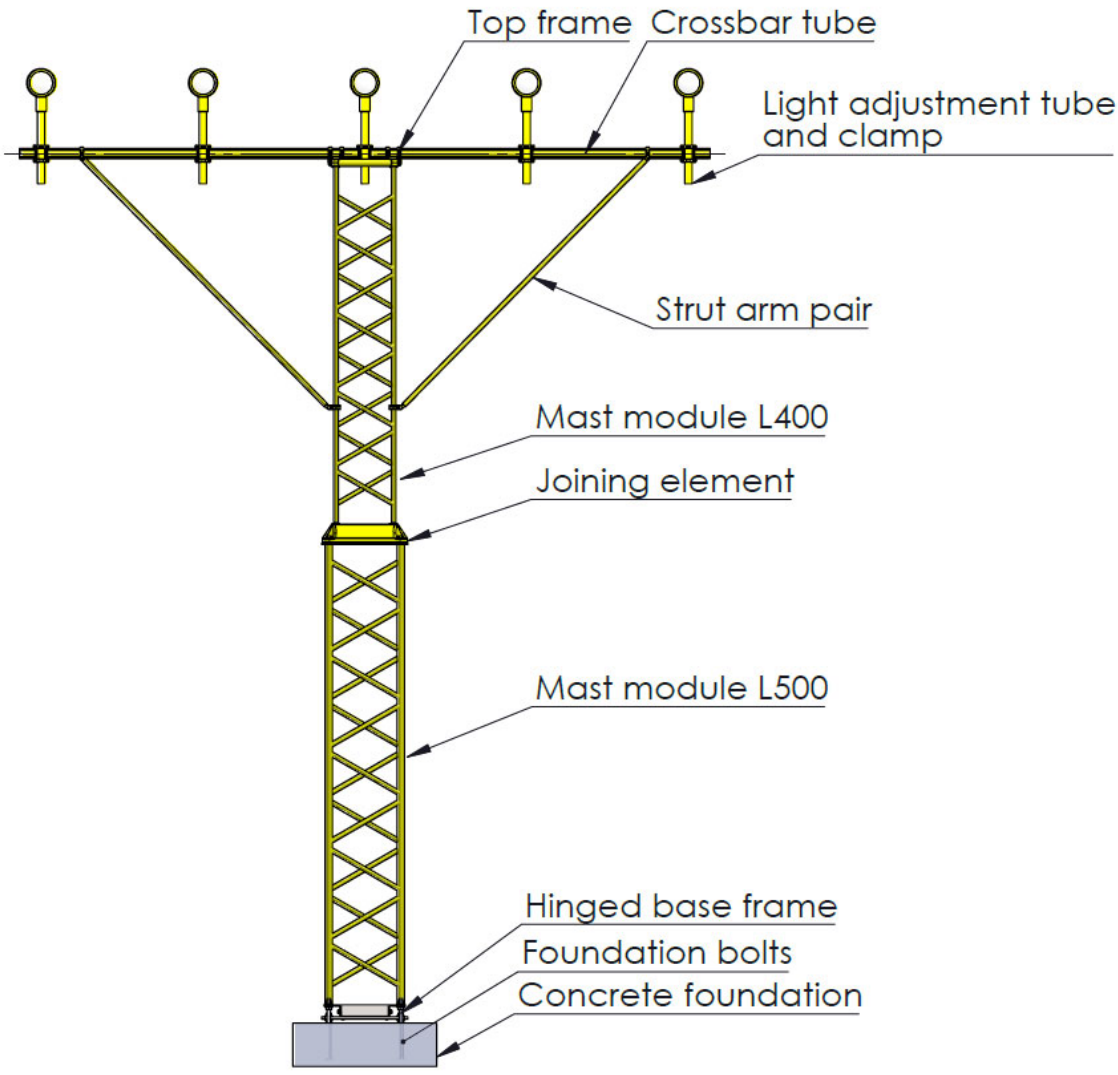


FIGURE 1. EXEL COMPOSITES PLC LATTICE APPROACH MAST

- The design of lattice masts has been explained more in detail in the assembly drawings and in the mast list.

2. FOUNDATION

2.1 FOUNDATION DESIGN

The factors affecting the foundation design are:

- Height of the mast
- Quantity of lights / mast (in lattice masts 1-5 pcs)
- Wind lad (including jet blast loads caused by the aircraft engines in the proximity of the threshold)
- Soil quality

The following tables describe some typical examples of mast foundations. The calculations have been made for tubular masts carrying single luminaires and lattice masts carrying barrettes of four luminaires. The maximum wind speed used in the calculations is 40 m/s. Dimensioning of the foundations has been done according to DIN 4017 : 2006.

Two types of foundations have been calculated, slab foundation and drum foundation.

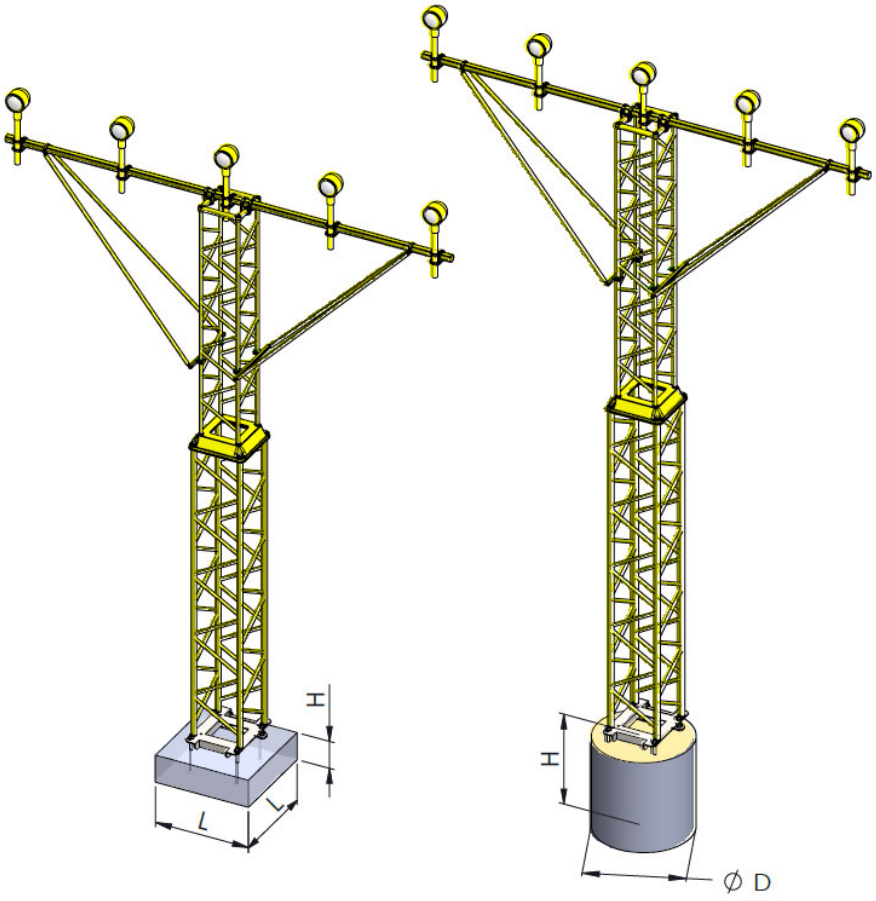


FIGURE 2. SLAB AND DRUM FOUNDATIONS

SLAB FOUNDATION		SOIL TYPE 1			SOIL TYPE 2			SOILT TYPE 3		
Mast height	Mast type	L=W	H	Mass	L=W	H	Mass	L	H	Mass
m		mm	mm	kg	mm	mm	kg	mm	mm	kg
H = 2,5	Tubular	600	200	170	600	200	170	700	200	250
H = 4	Tubular	700	300	350	600	300	260	800	400	620
H = 4	Lattice	1200	400	1400	1100	400	1200	1300	500	2100
H = 7	Lattice	1400	600	2900	1300	600	2500	1600	700	4400
H = 10	Lattice	1700	700	5000	1600	700	4400	1900	800	7100
H = 13	Lattice	1900	800	7100	1800	800	6350	2300	800	10400
H = 16	Lattice	2300	800	10400	2200	800	9500	2600	900	14900

TABLE 1. DIMENSIONS OF CONCRETE SLAB FOUNDATION

DRUM FOUNDATION		SOIL TYPE 1			SOIL TYPE 2			SOILT TYPE 3		
Mast height	Mast type	D	H	Mass	D	H	Mass	D	H	Mass
m		mm	mm	kg	mm	mm	kg	mm	mm	kg
H = 2,5	Tubular	500	800	390	500	600	280			
H = 4	Tubular	500	1000	480	500	800	390			
H = 4	Lattice	1200	1100	3000	1200	900	2500			
H = 7	Lattice	1200	1500	4150	1200	1200	3350			
H = 10	Lattice	1200	1900	5260	1200	1500	4200			
H = 13	Lattice	1200	2200	6100	1200	1700	4700			
H = 16	Lattice	1200	2600	7200	1200	2000	5600			

TABLE 2. DIMENSIONS OF CONCRETE DRUM FOUNDATION

Soil type 1: Sand, sandy soil
angle of friction $\delta = 25°$
weight by volume $\gamma = 17$ kN/m≥
cohesion c = 0 kN/m″

Soil type 2: Compacted coarse sand and moraine
angle of friction $\delta = 40°$
weight by volume $\gamma = 21$ kN/m≥
cohesion c = 0 kN/m″

Soil type 3: Hard clay (drum foundation should not be used!)
angle of friction $\delta = 0°$
weight by volume $\gamma = 19$ kN/m≥
cohesion c = 20 kN/m″

Concrete: > K30

- In a groundwater area the foundation shall be deeper.
- In a soil frost area, the foundation shall reach below the soil frost penetration depth.

- All design values mentioned in this instruction are purely indicative. Exel Composites Plc shall not take responsibility for their applicability to the area in question.
- It is highly recommended to always consult a local civil engineer about the dimensioning of the foundation.
- Exel Composites Plc will provide the necessary load calculations (shear force and bending moment), when requested.

- Positioning of masts is in the layout-drawing.
- The heights of the top of foundation are listed separately for each position in the mast list if this information has originally been provided to Exel Composites Plc.

2.2 PREPARATION OF FOUNDATION FOR HINGED BASE FRAME

Hinged base plate	
Part of foundation bolt remaining visible	170 ±2 mm
Allowed deviation of the position of the template / base	±0,5°
Frame from horizontal level	= 8,7 mm/1000 mm

TABLE 3. ESSENTIAL INFORMATION NECESSARY FOR PREPARATION OF HINGED BASE FOUNDATION

- Hot dip galvanised foundation bolts shall in no case be welded to the steel reinforcement of the foundation. Fasten the foundation bolts with wire.
- Protect the thread of the foundation bolts during the casting for example with tape.

- Plywood jigs should be used to facilitate concrete casting.
- The position of foundation bolts is the same for both 400 mm and 500 mm module masts.
- The same hinged base plate can be used for both 400 mm and 500 mm masts.
- See foundation bolt layout and casting template in appendices.

2.2.1 EQUIPMENT NEEDED FOR PREPARATION OF FOUNDATION

Measure	Instrument	Size
	Foundation bolt HMPL24/L-430, 4 pcs	M24-430
Fastening of foundation bolts to the jig	Nut, 8 pcs	M24
-:-	Washers, 8 pcs	Ø26
-:-	Wrench	S=36 mm
Positioning of foundation bolts	Casting jig 641794C 1 pc	For 400 or 500 mm mast
Protection of screw thread	Masking tape	-
Fastening of screws to steel reinforcement	Wire	-
Casting of foundation	Normal casting accessories (moulds and steel re-inf.)	-
Verification of straightness / angle of the jig	Water level	-

TABLE 4. EQUIPMENT NEEDED FOR PREPARATION OF FOUNDATION

2.2.2 WORK INSTRUCTIONS FOR CASTING OF FOUNDATION

- Make a cast mould with its steel reinforcements in accordance with the design of a local civil engineer.
- Place the cable duct tubes in foundation prior to casting. Recommended duct tube IR 65. The cable duct is drawn under the ground through the foundation up to and as close as possible to either inside corner of the base plate that is facing the felling direction of the mast.
- Fasten the foundation bolts to the casting template.
- Protect the threads in the anchor bolts by using, for example, tape.
- Place the casting template with its bolts at its' position. Fasten the bolts to the steel reinforcement with wire if necessary. The foundation bolts shall remain for the length of 170 mm above the concrete surface.
- Cast concrete in the foundation mould.
- Make sure that the casting template is in a horizontal position. Correct the position before the concrete hardens.
- When the concrete is hard, remove the casting template.

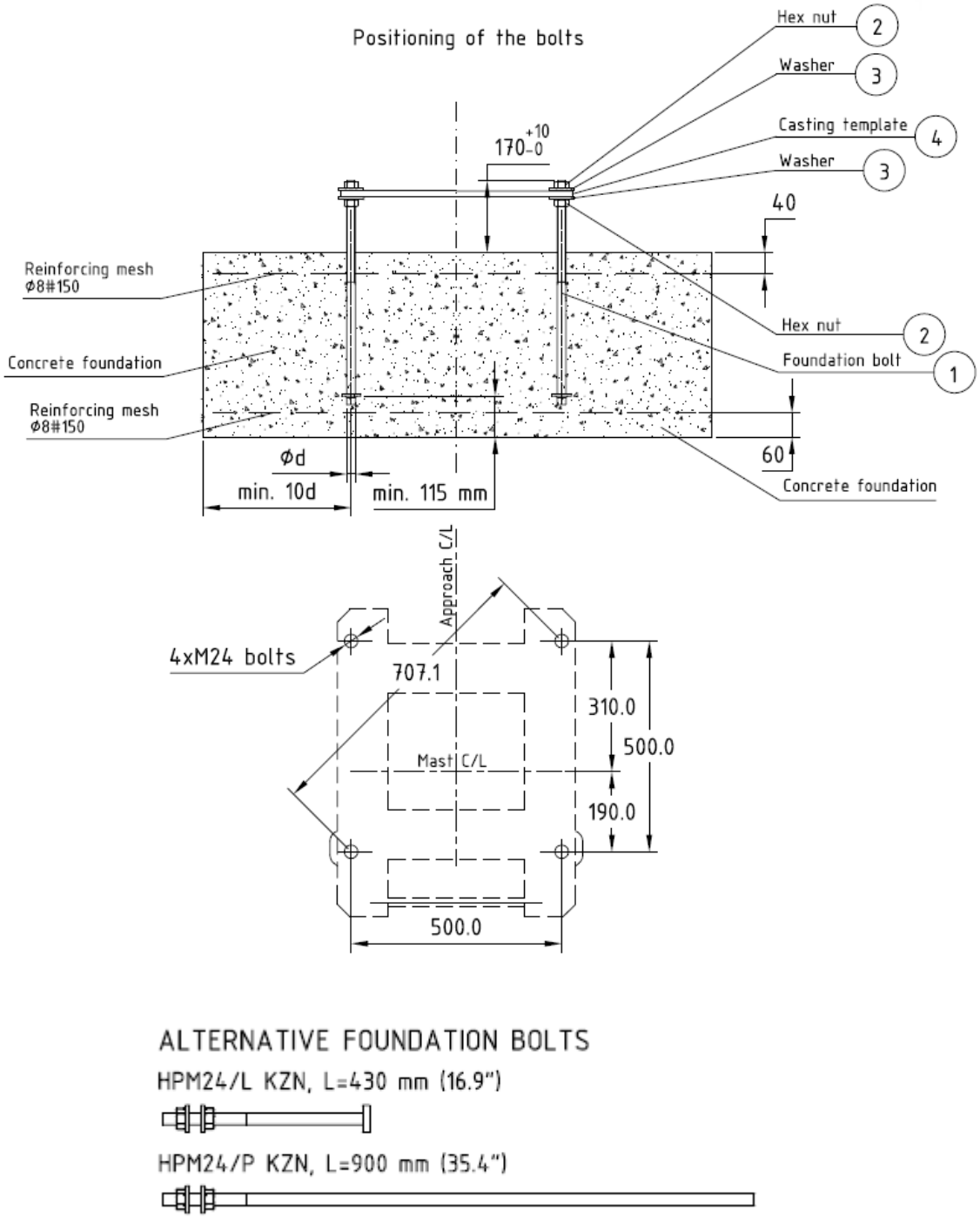


FIGURE 3. PRINCIPAL DRAFT OF FOUNDATION, CASTING JIG AND FOUNDATION BOLTS

2.3 PREPARATION OF FOUNDATION FOR FIXED BASE FRAME

Fixed base plate	
Part of foundation bolt remaining visible	150 +5 mm
Allowed deviation of the position of the jig/base frame from the approach light centre line.	±0,5° = 8,7 mm/1000 mm
Allowed deviation of the position of the jig/base frame from the horizontal level.	±1° = 17 mm/1000 mm
Correct position of the base frame	Even side up

TABLE 5. ESSENTIAL INFORMATION NECESSARY FOR PREPARATION OF FIXED BASE FOUNDATION

- Plywood jigs should be used to facilitate concrete casting.

- Hot dip galvanised foundation bolts shall in no case be welded to the steel reinforcement of the foundation. Fasten the foundation bolts with wire.
- Protect the thread of the foundation bolts during the casting for example with tape.

- See: ”Preparation of foundation for the erection of the mast”.
- See: ”Installation of electrical wires”.
- See foundation lay-out drawings in appendices

2.3.1 EQUIPMENT NEEDED FOR PREPARATION OF FOUNDATION

Measure	Instrument	Size
L500 mast module foundation		
	Foundation bolt HMP24/L-430 or HPM24/P-900, 4 pcs	M24-430 or M24-900
Positioning of foundation bolts (alternative 1)	Casting jig 641934A, 1 pc	M24, 4 holes
Fastening of foundation bolts to the jig (alt. 1)	Nut, 8 pcs	M24
-:-	Threaded washers, 4 pcs	Ø60/M24
-:-	Washers, 8 pcs	Ø60/24
Positioning of foundation bolts (alt. 2)	Base frame, 1 pc	500 mm
Fastening of foundation bolts to the base frame (alt. 2)	Nuts, 8 pcs	M24
L400 mast module foundation		
Positioning of foundation bolts (alternative 1)	Casting jig 641830C, 1 pc	M20, 4 holes
Fastening of foundation bolts to the jig (alt. 1)	Nut, 8 pcs	M20, 4 holes
-:-	Threaded washer, 4 pcs	Ø60/M20
-:-	Washer, 8 pcs	Ø60/20
Positioning of foundation bolts (Alternative 2.)	Base frame 1 pc	400 mm
Fastening of foundation bolts to the base frame (alt. 2)	Nuts, 8 pcs	M20
Tools and accessories		
Tools	Fork spanner, 2 pcs	S=36 mm
Protection of screw thread	Masking tape	
Fastening of screws to steel reinforcement	Wire	
Casting of foundation	Normal casting accessories (moulds and steel re-inf.)	
Verification of straightness / angle of the jig	A stiff ruler	L > 1000 mm
-:-	Water level	

TABLE 6. EQUIPMENT NEEDED FOR FOUNDATION PREPARATION

2.3.2 WORK INSTRUCTIONS FOR CASTING OF FOUNDATION

Foundation drawings can be found in appendices.

If a locating jig is not available, the base frame can be used as a jig. Fit the base frame with washers and bolts. They will centre the foundation bolts to the holes in the base frame and make sure that the bolts will be positioned accurately at their correct places in the concrete. Make a cast mould with its steel reinforcements in accordance with the design of a local civil engineer.

- The cable conduit is drawn under the ground from the transformer housing through the foundation up to and as close as possible to either inside corner of the base plate that is facing the erecting direction of the mast.
- Fasten the foundation bolts to the casting jig. If you use the base frame as a jig, make sure that you fasten and install the bolts correctly in accordance with the enclosed illustration, the flat surface up.
- Protect the threads in the anchor bolts by using for example masking tape.
- Place the casting jig (or the base frame) with its bolts at its' position. Fasten the bolts to the steel reinforcement with wire if necessary. The foundation bolts shall remain for the length of 150 mm above the concrete surface (100 mm if a steel post is used as the first module).
- Make sure that the base frame is in straight angle towards the approach light centre line. The allowed deviation of the position of the jig/base frame from the approach light centre line. ±0,5°, which corresponds to 8,7 mm/1000 mm. Correct if necessary.
- Cast concrete in the foundation mould.
- Make sure that the cast jig (or base frame) is in a horizontal position. Correct the position before the concrete hardens.
- When the concrete is hard, remove the cast jig (or base frame).

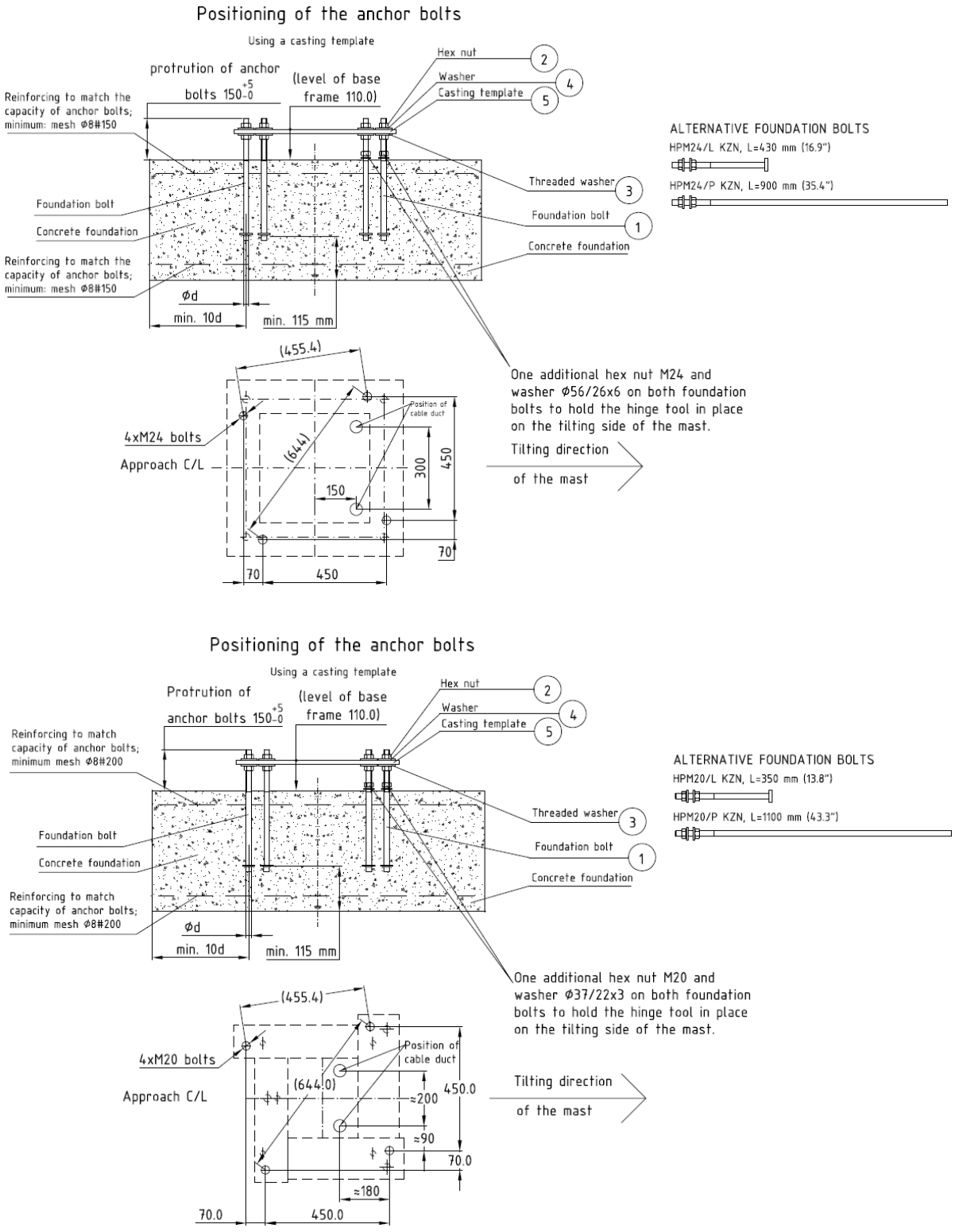


FIGURE 4. PRINCIPAL DRAFT OF FOUNDATION, CASTING JIG AND FOUNDATION BOLTS

3. LATTICE MAST

3.1 MAIN DIMENSIONS OF TYPE OF MAST

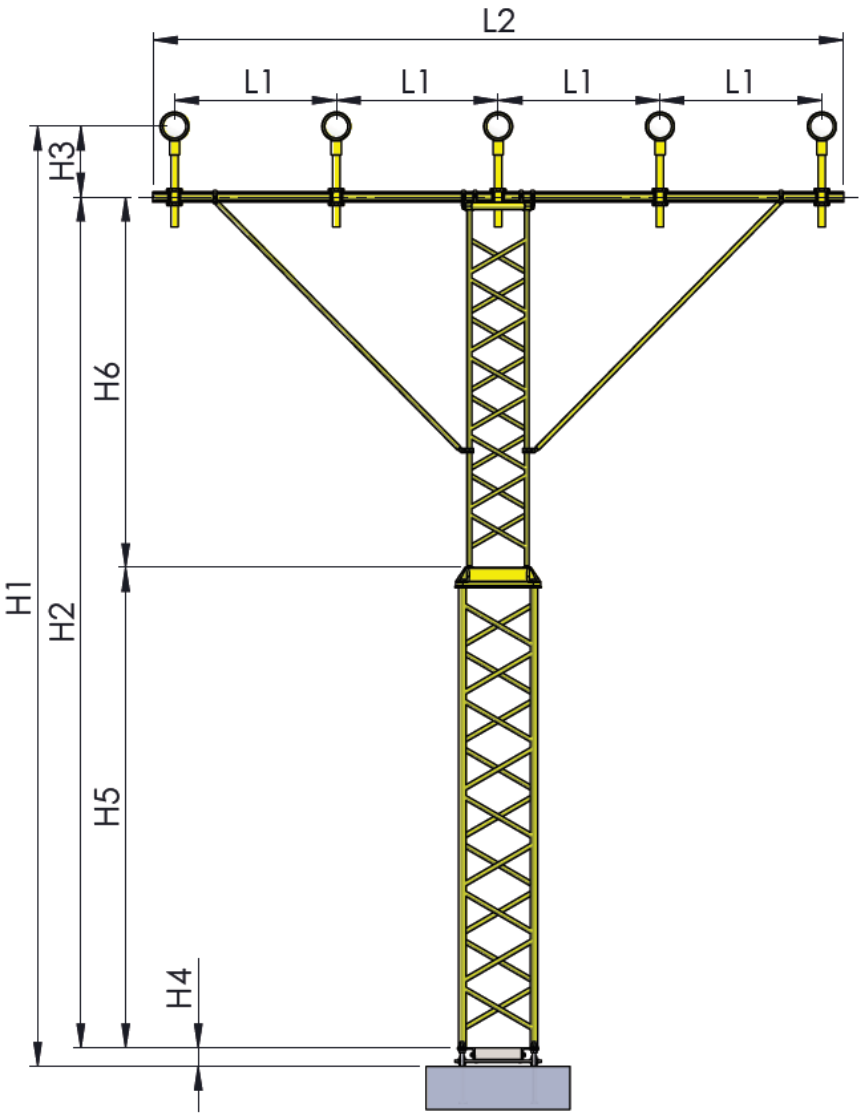


FIGURE 5. MAIN DIMENSIONS OF TYPE OF MAST

Dimension	Explanation
H1	Light height from top of foundation
H2	Height of lattice section
H3	Light height from top of lattice section
H4	Height of the base frame top from top of foundation
H5	Height of 400 mm mast module
H6	Height of 500 mm mast module
L1	Horizontal spacing of approach lights
L2	Length of the cross bar

TABLE 7. EXPLANATIONS OF MAIN DIMENSIONS OF TYPE OF MAST

3.2 UNPACKING AND HANDLING OF MAST

Unpack the mast carefully on the assembly site. Handle mast modules with care. Be sure not to damage the glass fibre structures, because they are de-signed to be frangible.

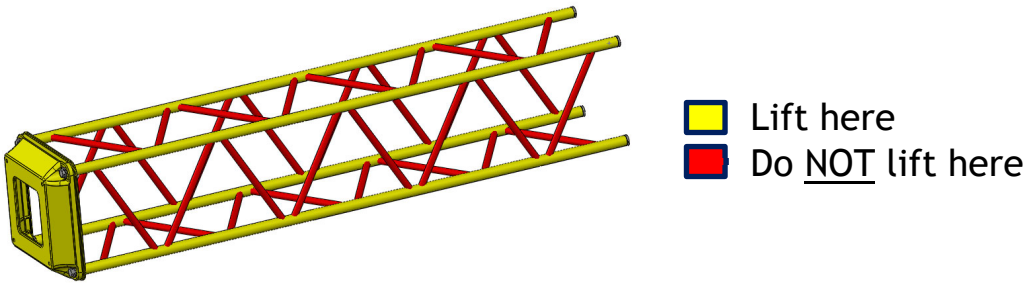


FIGURE 6. MAST HANDLING

Masts are delivered as assembled modules, which will then be connected on the assembly site. The 400 mm mast module is packed inside the 500 mm module. They have been numbered by positions accord-ing to a separate mast list.

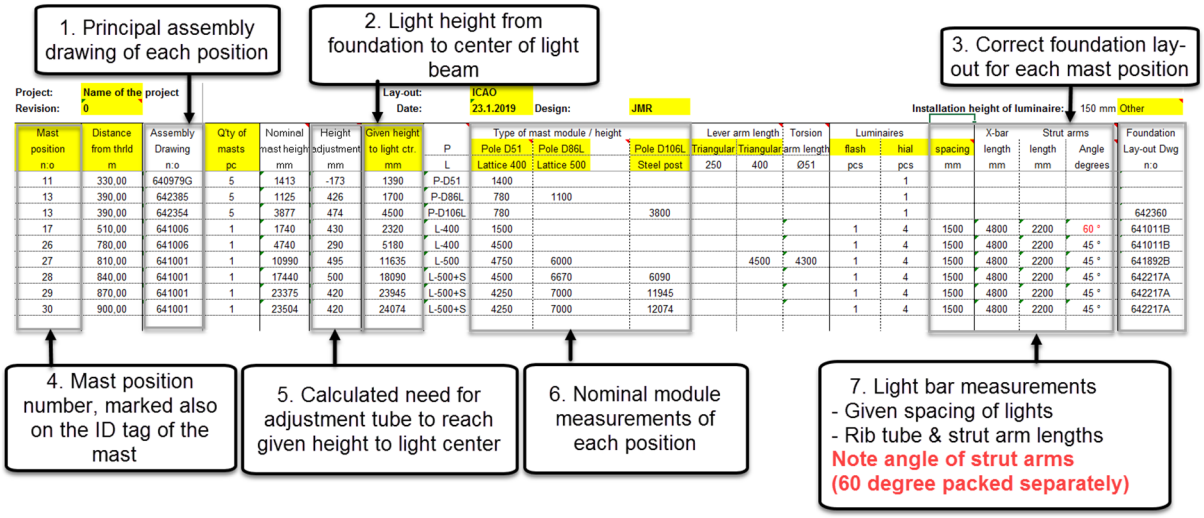
A joint element is mounted on top of the 500 mm module. This joint element is used for connecting modules of different sizes. On top of the 400 mm module is the top frame, on which the crossbar tube is mount-ed. All necessary screws, nuts, washers and shims have been fitted.

When unpacking, arrange modules according to mast list so that differ-ent elements of the mast will not get mixed with each other during as-sembly.

i	• If any damage is found in the masts, contact the representative of Exel Composites Plc. Exel will either repair the damaged parts or provide the repairing instructions.
☞	• Make sure that the masts have not been damaged during transportation. • Recommended lifting points of a mast are the top frame, the joint element and the base frame. In addition to those points, mast modules may only be lifted from leg beams. Never lift a mast from diagonal beams! • Be careful not to damage masts during treatment, because they are designed to be frangible.
↱	• Mast modules have been numbered according to their positions. The numbers refer to a separate assembly drawing. See assembly drawings in appendices.

3.3 MAST LIST

Mast list is used as a summary of main components needed for the assembly. Also in case of need for spare parts Exel Composites keeps an archive of all past deliveries which can be ordered based on the mast list or information on ID-tag attached for each mast.



Mast position n:o	Distance from thrld m	Assembly Drawing n:o	Q'ty of masts pc	Nominal mast heigh mm	Height adjustment mm	Given height to light ctr. mm	P L	Type of mast module / height Pole D51 Lattice 400	Pole D86L Lattice 500	Pole D106L Steel post	Lever arm length Triangular 250	Triangular 400	Torsion arm length Ø51	Luminaires flash pcs	hial pcs	spacing mm	X-bar length mm	Strut arms length mm	Angle degrees	Foundation Lay-out Dwg n:o
11	330,00	640979G	5	1413	-173	1390	P-D51	1400							1					
13	390,00	642385	5	1125	426	1700	P-D86L	780	1100						1					
13	390,00	642354	5	3877	474	4500	P-D106L	780		3800					1					642360
17	510,00	641006	1	1740	430	2320	L-400	1500						1	4	1500	4800	2200	60 °	641011B
26	780,00	641006	1	4740	290	5180	L-400	4500						1	4	1500	4800	2200	45 °	641011B
27	810,00	641001	1	10990	495	11635	L-500	4750	6000			4500	4300	1	4	1500	4800	2200	45 °	641892B
28	840,00	641001	1	17440	500	18090	L-500+S	4500	6670	6090				1	4	1500	4800	2200	45 °	642217A
29	870,00	641001	1	23375	420	23945	L-500+S	4250	7000	11945				1	4	1500	4800	2200	45 °	642217A
30	900,00	641001	1	23504	420	24074	L-500+S	4250	7000	12074				1	4	1500	4800	2200	45 °	642217A

1. Principal assembly drawings can be found in attachments of this manual
2. Light height is given by the customer in ordering phase, mast module sizes are determined based on this also considering needed adjustment level
3. Correct foundation lay-out depend on the mast type, detailed information can be found in attachments of this manual
4. Mast position is an individual ID for each mast given by the customer or set by Exel composites
5. Height adjustment is explained in appendix 642074
6. Nominal module measurements are shown as reference
7. Detailed measurements of light bar for each position

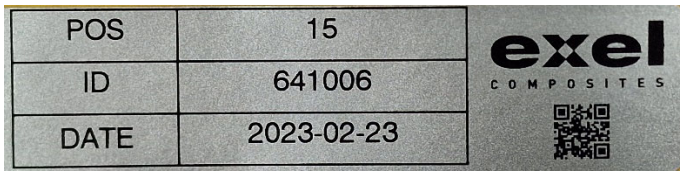
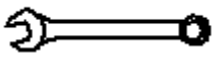
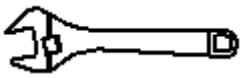
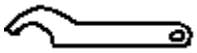


FIGURE 7. EXAMPLE OF A MAST IDENTIFICATION STICKER

4. MAST TYPE ASSEMBLY

4.1 JOINING OF MAST MODULES

4.1.1 REQUIRED EQUIPMENT AND TOOLS

- Fork spanners  or adjustable wrench 
- Torque wrench set
- Hook wrenches  (delivered by Exel)
- Allen keys 
- Electric screw machine (for Allen screws)
- Water level 
- Optic device
- Trestles and block of woods (to support and aligning the mast modules)

Mast module	Action	Tool	Size
500 m	Tightening of M24 fastening screw	Fork Spanner	S = 36 mm
400 m	Tightening of M16 fastening screw	Fork spanner	S = 24 mm
Both	Applying torque against tightening	Hook wrench	32/50 mm
Locking bar assembly	Tightening of Allen screws	Allen key bit	S = 6 mm
-:-	-:-	Allen key	S = 4 mm
-:-	-:-	Allen key	S = 6 mm
	Final tightening of screws	Torque wrench	M = 20 Nm
	-:-	Torque wrench	M = 300 Nm
	Adjustment of upright position of mast	Water level	
	Adjustment of the alignment	Optic device	

TABLE 8. TOOLS NEEDED FOR INSTALLING THE LATTICE MAST

4.1.2 USAGE OF A HOOK WRENCH TOOL

Hook wrench tool is to be used when tightening the screws of mast modules. This way no torsion stress will be directed to the glass fibre construction of the leg beams.

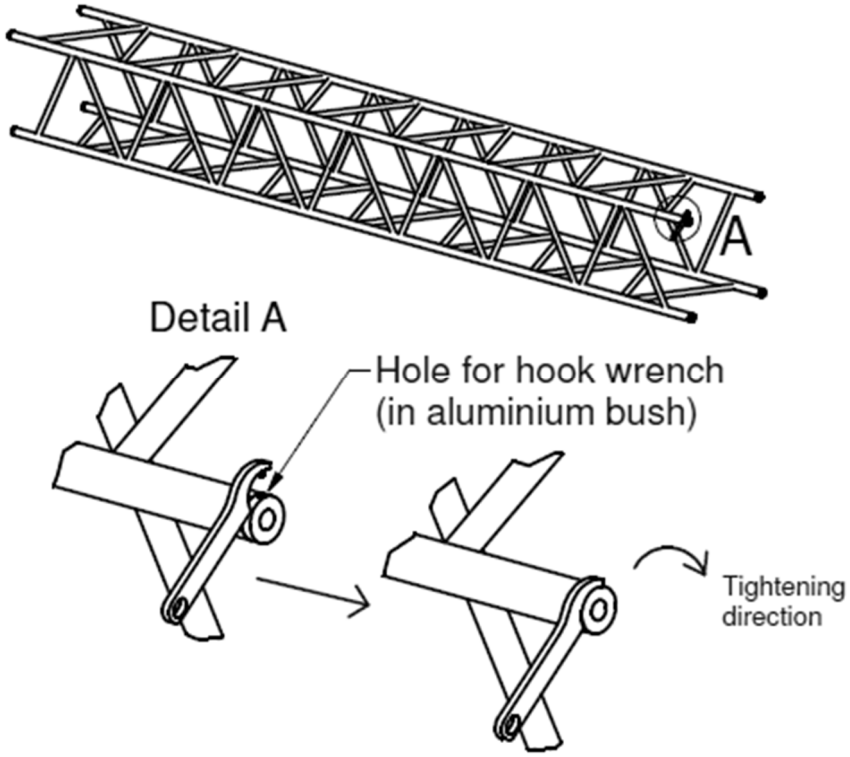


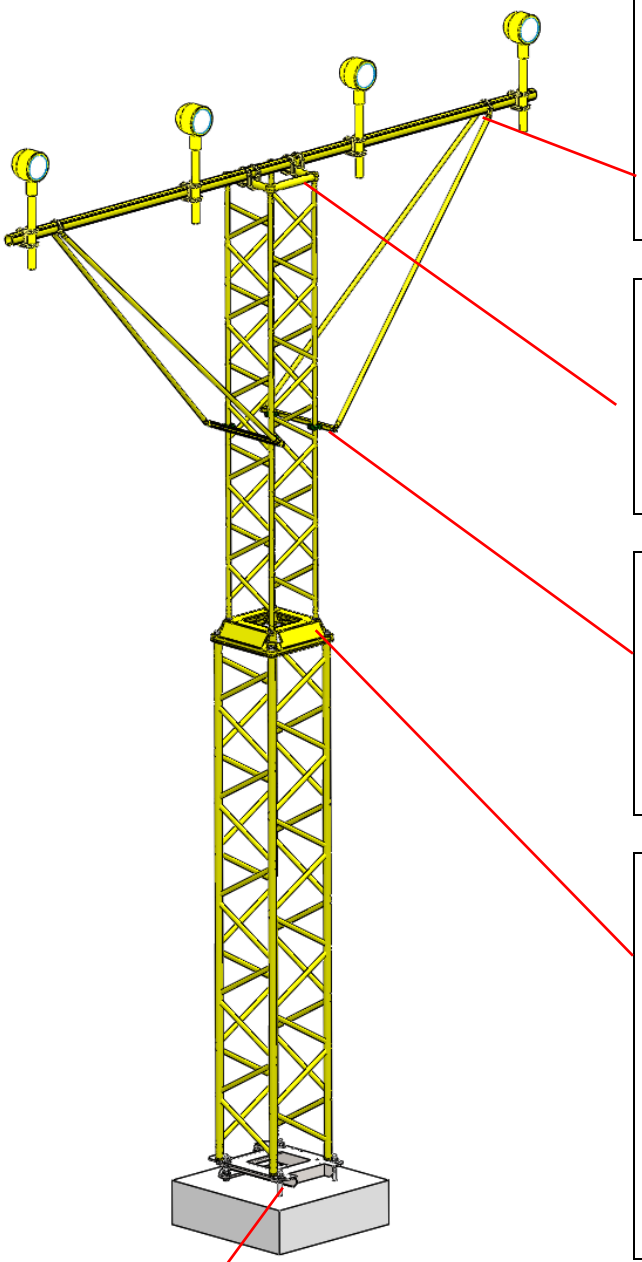
FIGURE 8. HOOK WRENCH USAGE

Use a hook wrench when applying torque against tightening. There is a hole in the aluminium bush at the end of the leg beam.

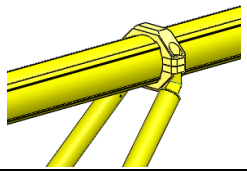
- If the hole in the leg beam bush is over painted or covered by glue, clean the hole that hook wrench can be used.

- A hook wrench must be used for applying torque against tightening. Torsion stress caused by tightening shall not be directed to the glass fibre structure of the leg beam.

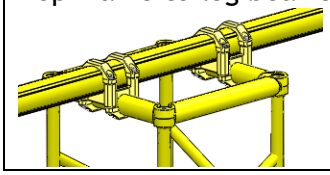
4.1.3 TORQUES, JOINT ELEMENT & HINGED BASE



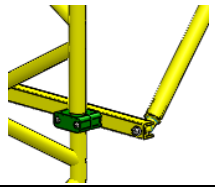
Item	Size	Torque
Strut arms to cross member clamp	M8	13 Nm



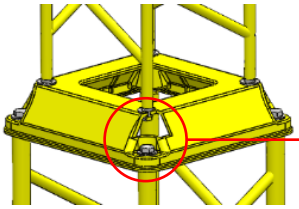
Cross member clamps	M8	13 Nm
Top frame to leg beams	M16	80 Nm

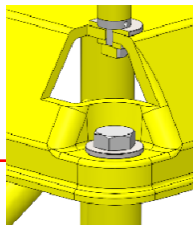


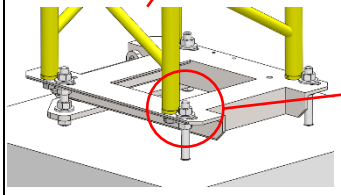
Horizontal support to leg beams	M6	5 Nm
Strut arms to horizontal support	M8	13 Nm

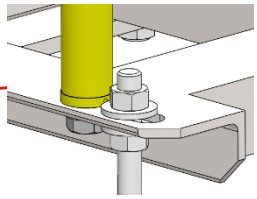


L400 leg beams to joining element	M16	130 Nm
Joining element to L500 leg beams	M24	200 Nm



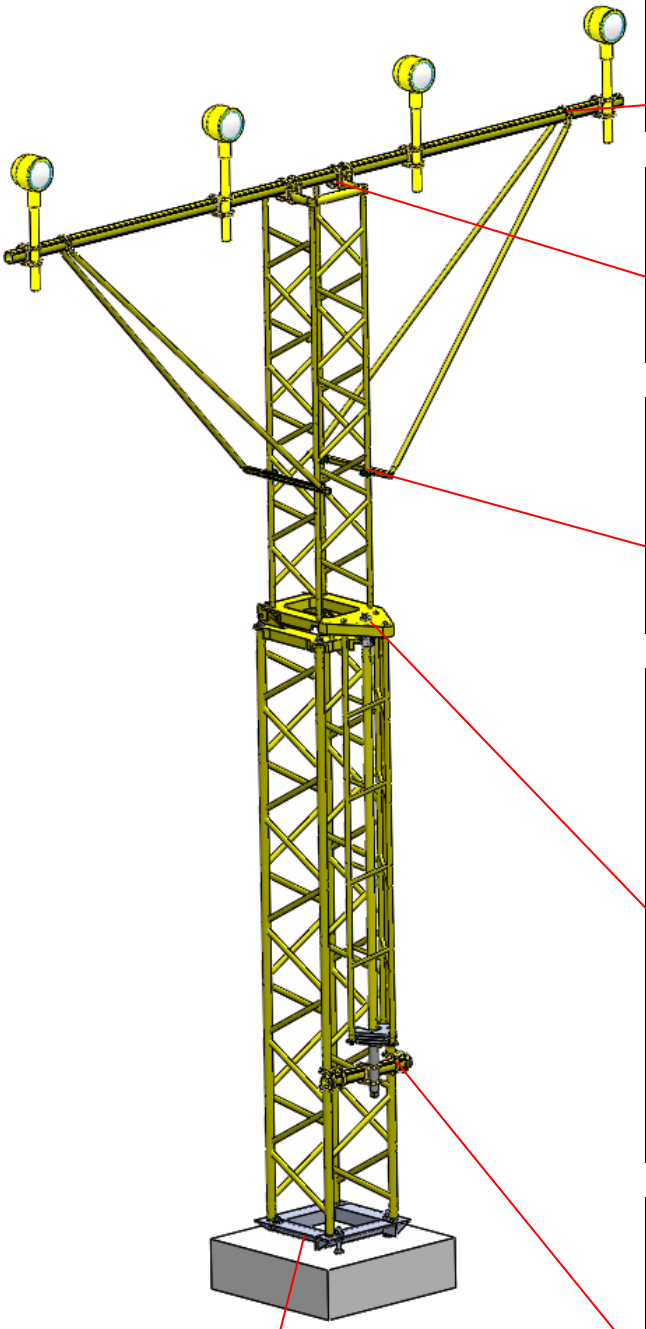




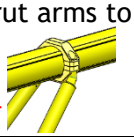


L400 leg beams to base frame	M16	150 Nm
Base frame to anchor bolt	M20	200 Nm
L500 leg beams to base frame	M24	250 Nm
Base frame to anchor bolts	M24	300 Nm

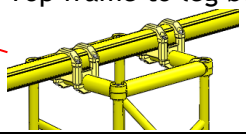
4.1.4 TORQUES, CENTER HINGE & FIXED BASE



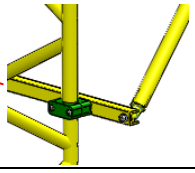
Item	Size	Torque
Strut arms to cross member clamp	M8	13 Nm



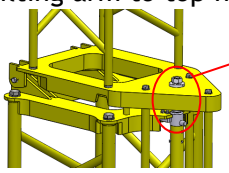
Cross member clamps	M8	13 Nm
Top frame to leg beams	M16	80 Nm

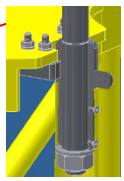


Horizontal support to leg beams	M6	5 Nm
Strut arms to horizontal support	M8	13 Nm



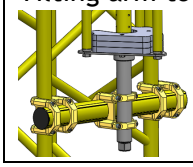
L400 leg beams to centre hinge top half	M16	130 Nm
Centre hinge bottom half to L500 leg beams	M24	200 Nm
Tilting arm to top half of centre hinge	M16	130 Nm

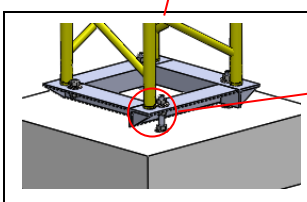


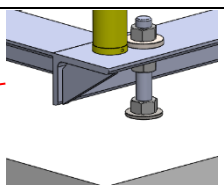


Torsion tube to locking shaft		
Bottom nut of shaft (torqued at the manufacturer's plant)	M5 M24	2 Nm 210 Nm

Torsion arm clamping beam to leg beams	M8	13 Nm
Tilting arm to bottom plate	M16	130 Nm







L400 leg beams to base frame	M16	150 Nm
Base frame to anchor bolts	M20	200 Nm
L500 leg beams to base frame	M24	250 Nm
Base frame to anchor bolts	M24	300 Nm

4.2 LATTICE MAST ASSEMBLY WITH JOINT ELEMENT

Tall masts consist of two modules. The modules of 400 mm and 500 mm are joined by using a joint element.

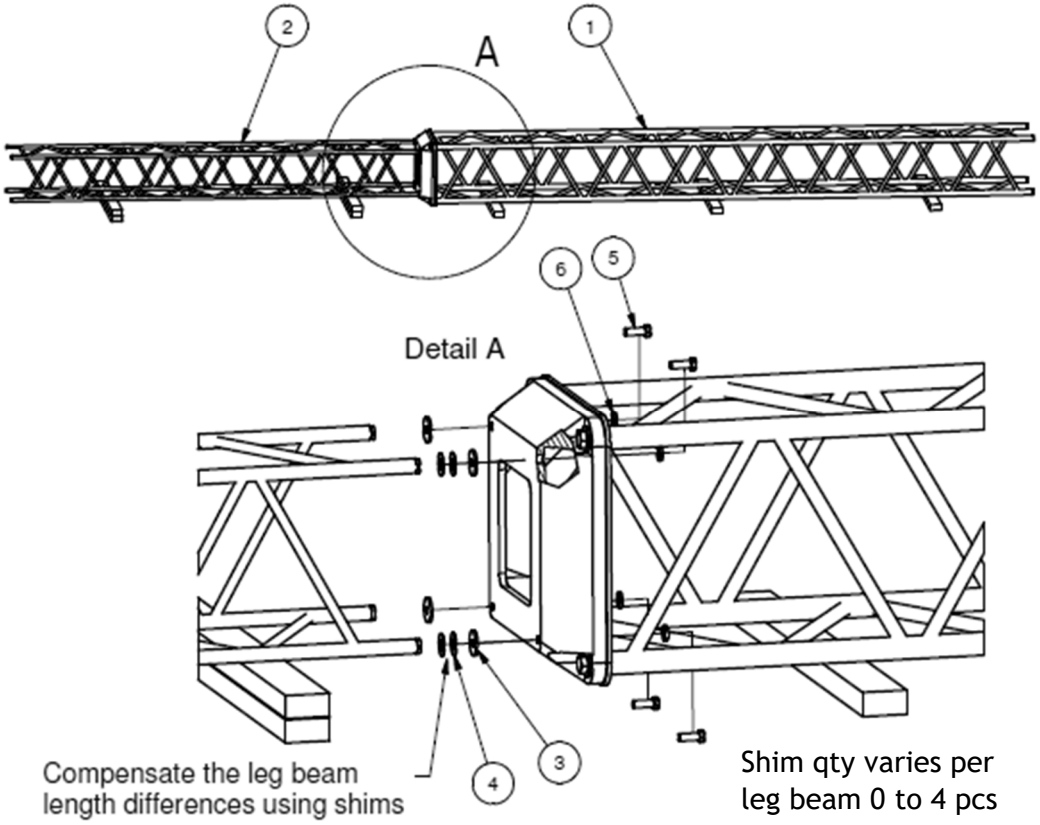


FIGURE 9. MAST MODULES IN ASSEMBLY POSITION

No.	Part Name	Size / model / ref.	Qty
1	Mast module	500 mm	1
2	Mast module	400 mm	1
3	Washer	Ø55/16x5	4
4	Shim	Ø50/24x0.5	n
5	Hex screw	M16x40	4
6	Washer	Ø34/16x5	4

TABLE 9. LIST OF CONNECTION PARTS

Work instructions:

- Place modules in a lying position on wooden support frames placed on an even base.
- Compensate the length differences of leg beams by using shims under a shorter leg beam.
- Choose modules to be joined according to the position numbers according to **mast list**.

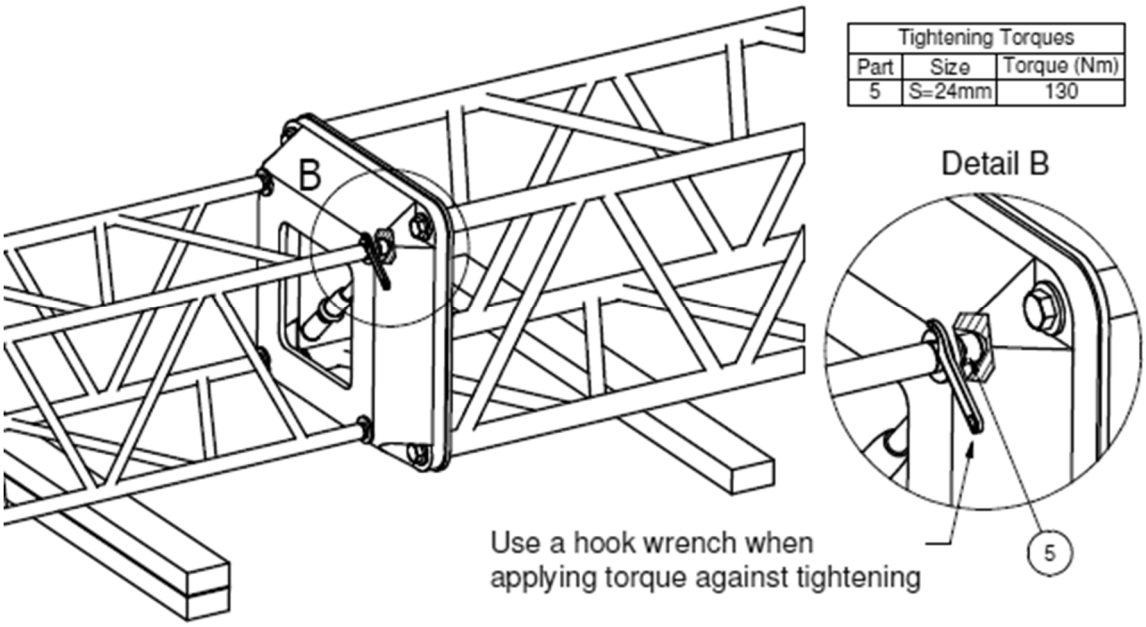


FIGURE 10. TIGHTENING JOINT ELEMENT SCREWS

- Make sure that all the bolts of the joint element have been tightened to their torque setting.

- Shims must be used for all leg beams in order to even the torsion load. Never tighten the leg beams to the level of the joint element by force. The diagonal beams are designed to be frangible.
- A hook wrench must be used for applying torque against tightening. Torsion stress caused by tightening shall not be directed to the glass fibre structure of the leg beam.

4.3 LATTICE MAST ASSEMBLY WITH CENTRE HINGE

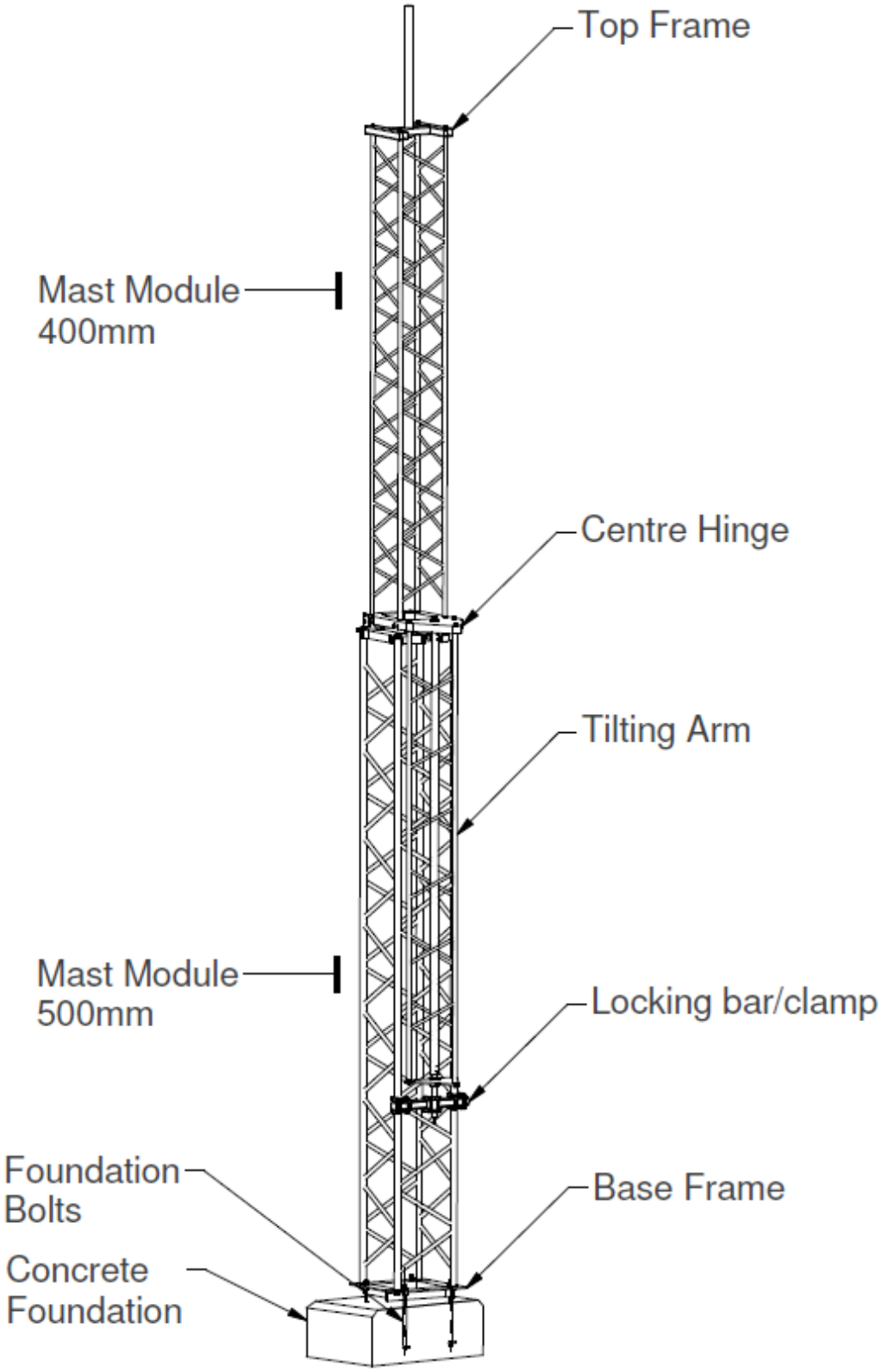


FIGURE 11. CENTRE HINGED EXEL LATTICE MAST

4.3.1 WORK INSTRUCTIONS FOR JOINING MAST MODULES

Centre hinged masts consist of two modules. The modules of 400 mm and 500 mm are joined by using a centre hinge. The tilting arm is connected to the hinge.

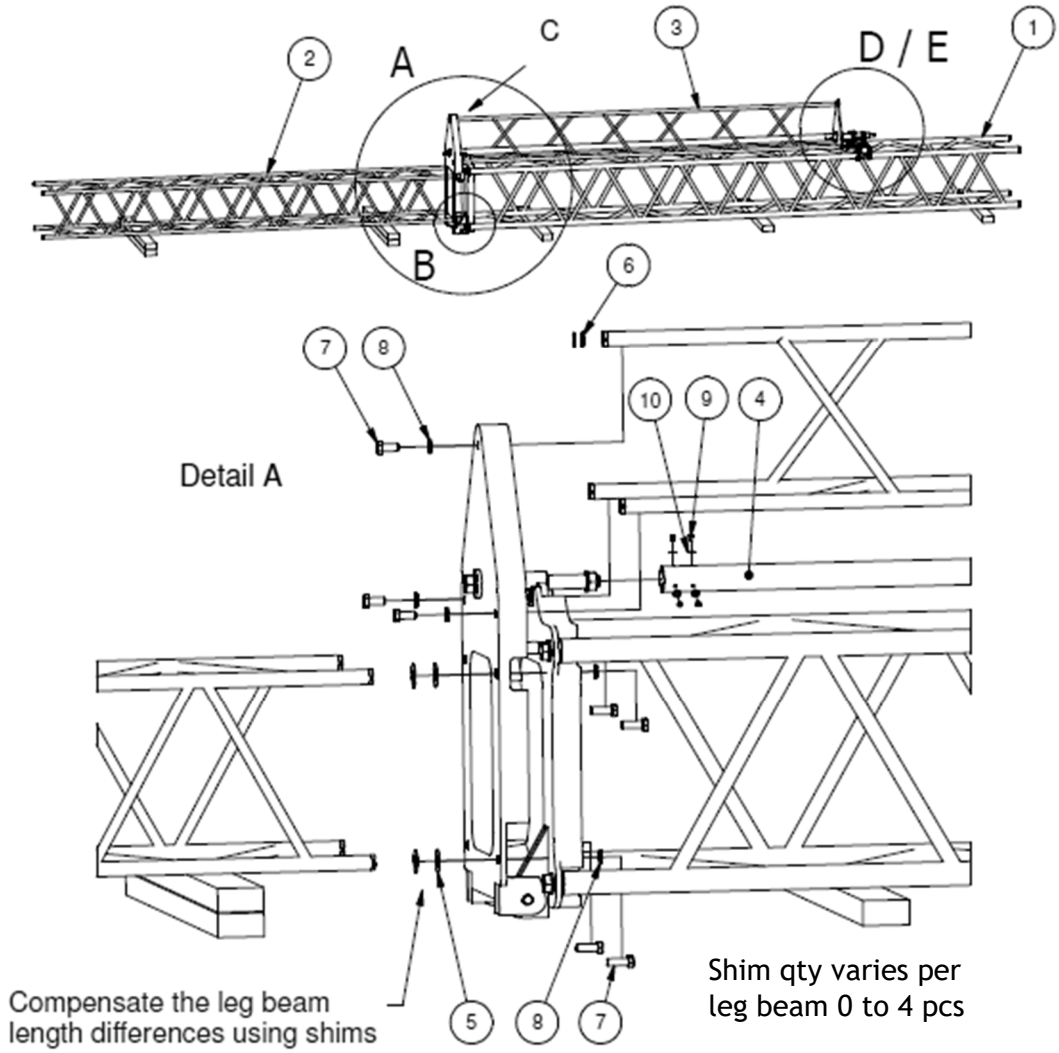


FIGURE 12. MAST MODULES IN ASSEMBLY POSITION

No.	Part Name	Size / model / ref.	Qty
1	Mast module	500 mm	1
2	Mast module	400 mm	1
3	Tilting arm module	300 or 400 mm	1
4	Torsion arm	Ø50/46	1
5	Shim	Ø50/24x0.5	n
6	Shim	Ø32/17x0.5	n
7	Hex screw	M16x40	7
8	Washer	Ø34/16x5	7
9	Allen screw	M5 x 10	12
10	Bonded washer	Ø16 x 6,8	12
11	Base plate	250/400 mm	1
12	Torsion shaft	Ø50 x 400	1

TABLE 10. LIST OF CONNECTION PARTS

- Place modules in a lying position on wooden support frames placed on an even base.
- Compensate the length differences of leg beams by using shims under a shorter leg beam.

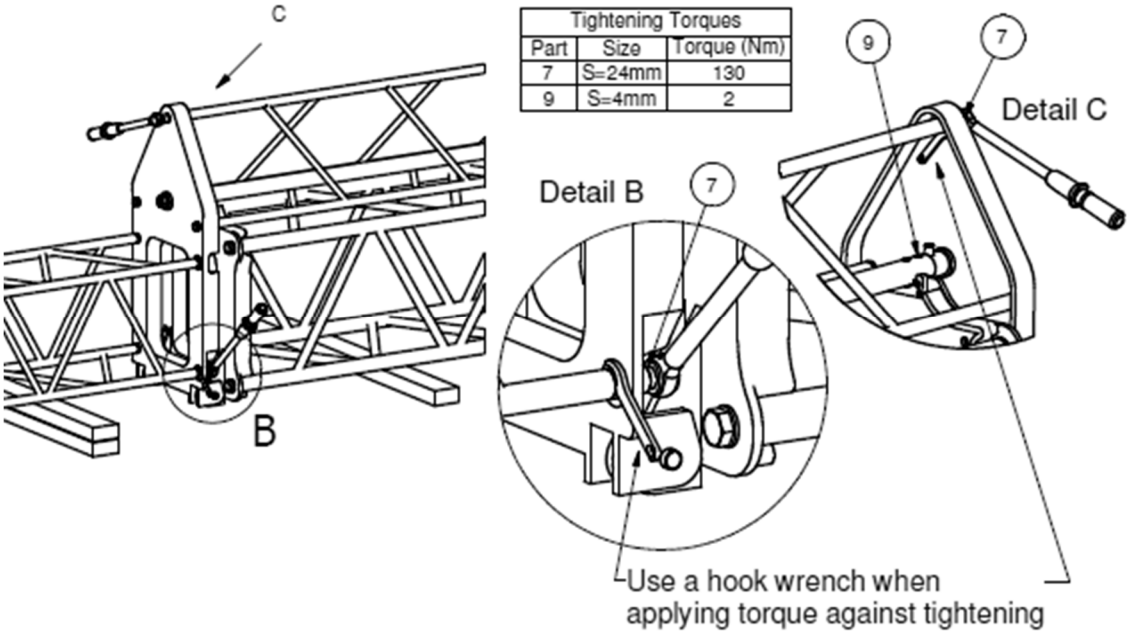


FIGURE 13. TIGHTENING CENTRE HINGE SCREWS

- Make sure that the bolts of the centre hinge have been tightened to correct torque.
- Direct the torsion arm through the hole in the base plate all the way to and over the locking bush.

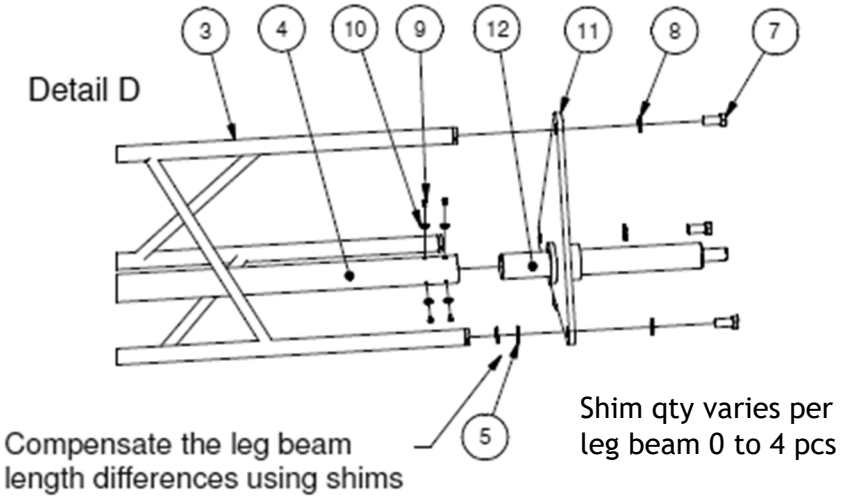
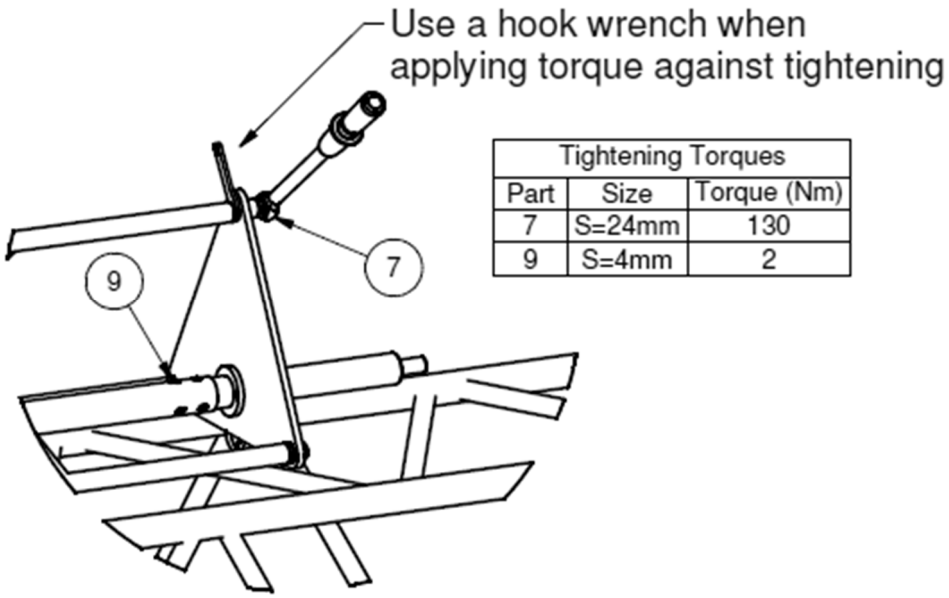


FIGURE 14. ASSEMBLING TILTING ARM PARTS

- Place bonded washers under all the torsion arm screws. The rubber side shall be against the glass fibre tube.



Tightening Torques		
Part	Size	Torque (Nm)
7	S=24mm	130
9	S=4mm	2

FIGURE 15. TIGHTENING TILTING ARM SCREWS

- Tighten the screws of the tilting arm to their torque setting.

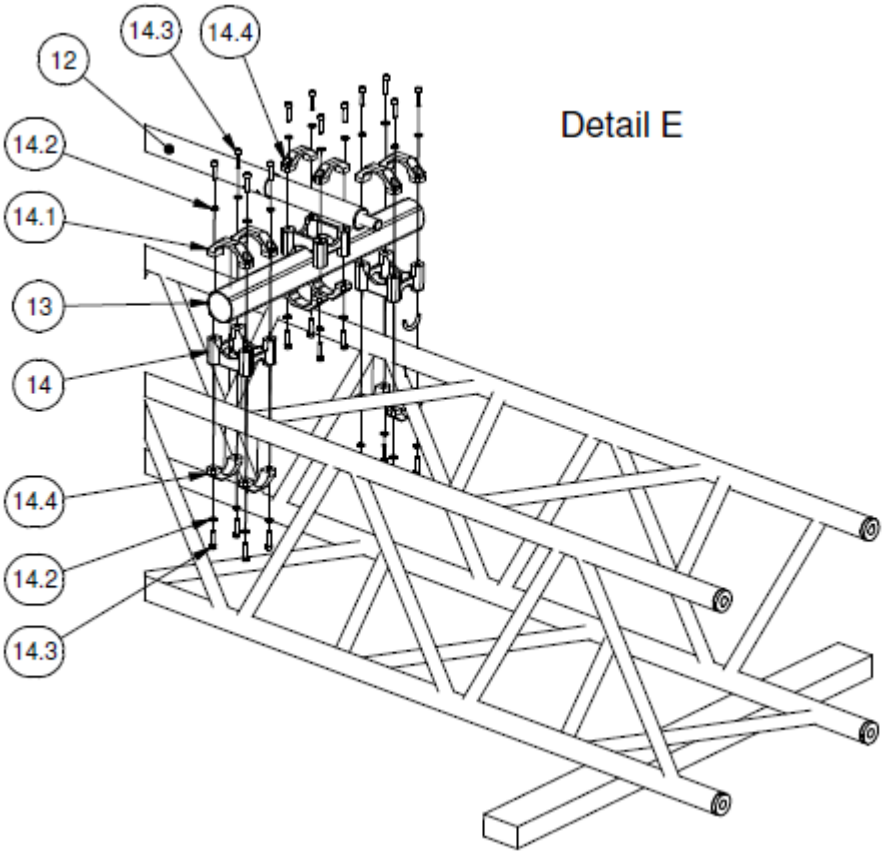


FIGURE 16. INSTALLATION OF LOCKING ARM CLAMP

- Install the cross bows to leg beams and set the rib tube in the clamps.
- Install the locking bar clamp. Measure the distance from the bottom of the mast module as shown in the illustration above.

No.	Part Name	Size / model / ref.	Qty
13	Rib tube	Ø72 - 650 mm	1
14	Clamp frame	Ø72/ ø51 (or ø53)	3
14.1	Cross bow	Ø72	6
14.2	Washer	Ø16/8,4	24
14.3	Allen screw	M8x35	24
14.4	Clamp	Ø51 (or ø53)	6

TABLE 11. LIST OF CLAMP CONNECTION PARTS

- The clamp must be precisely in correct position to allow tightening of the screws in centre clamp.

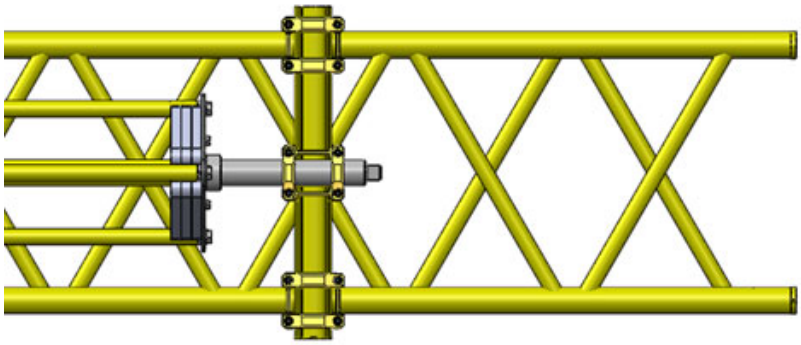


FIGURE 17 . ADJUST THE LOCKING ARM CLAMP POSITION

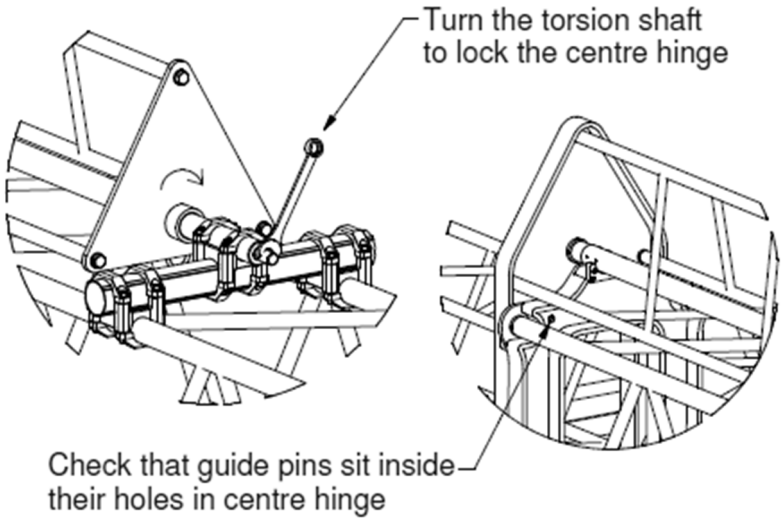
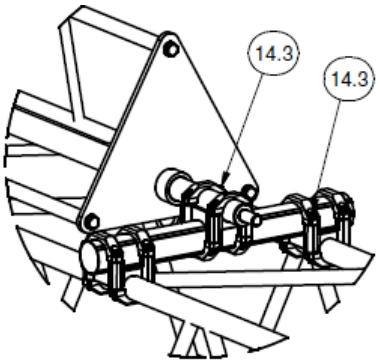


FIGURE 18. LOCK THE CENTRE HINGE

- Turn the torsion shaft to lock the centre hinge and check that guide pins sit inside their holes in the bottom section of the hinge.
- If the locking arm clamp sits like shown in figure 13, you can tighten all the screws in the clamp.
- Tighten the screws of the clamps to their torque settings.



Tightening Torques		
Part	Size	Torque (Nm)
14.3	S=6mm	13

FIGURE 19. TIGHTEN THE PANEL CLAMPS

5. INSTALLATION OF THE TOP SECTION OF THE MAST

The installations of the top section of the mast include mounting of cross bars, strut arm supports and approach lights. See the illustration below.

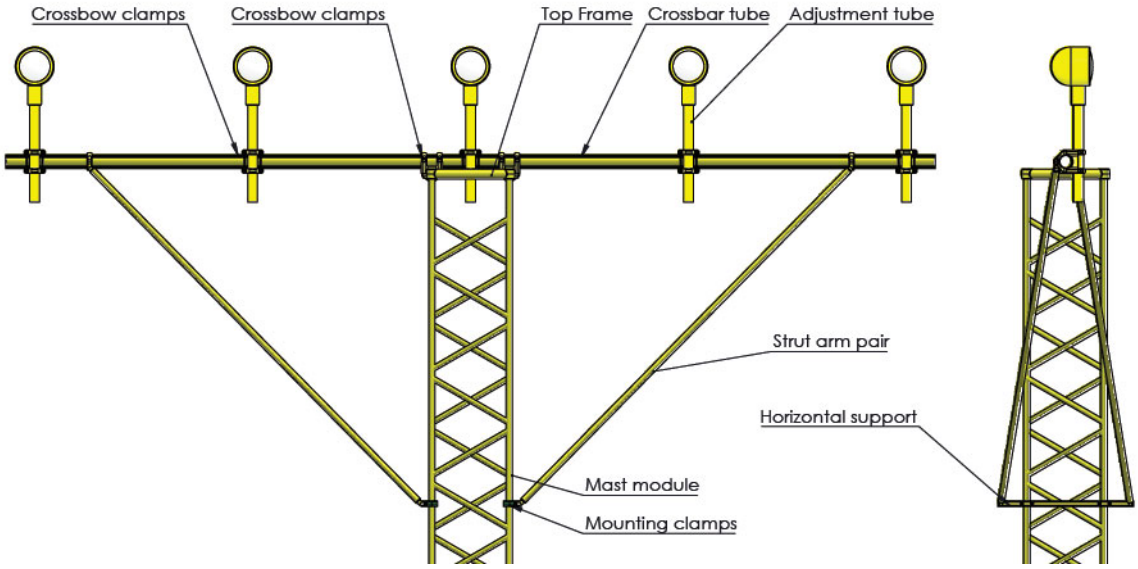


FIGURE 20. INSTALLATION OF THE MAST TOP SECTION

5.1 INSTALLATION OF CROSSBAR AND STRUT ARMS

5.1.1 TOOLS NEEDED FOR MOUNTING THE TOP SECTION

Action	Tool	Size
Final tightening of screws	Torque wrench	M20
Cross bar tube clamp, tightening of M8 screw	Allen key	S=6 mm
Strut arm clamp, tightening of M8 screw	Allen key	S=6 mm
Horizontal support of strut arms, tightening of M6 screw	Allen key	S=5 mm

TABLE 12. TOOLS NEEDED FOR MOUNTING THE TOP SECTION OF THE MAST

Object	Screw size	Torque
Cross bar tube clamp	M8	13 Nm
Strut arm clamp	M8	13 Nm

TABLE 13. MAST TOP SECTION INSTALLATION TIGHTENING TORQUES

5.1.2 TOP FRAME

A top frame has been mounted to the top of the mast for installation of the cross bar. The cross bar tube will be mounted on the mast with clamps in the top frame.

- Check that the clamps and the cross bar are on the centre line of the mast.

5.1.3 WORK INSTRUCTIONS FOR INSTALLATION OF CROSS BAR TUBE

Cross bar tube will be mounted on the top frame with cross bar clamps. The misalignment of the tube is prevented with the ribs in the tube. There are grooves for the ribs in the clamp frame and in the crossbow.

- Check that the ribs fit in their grooves during installation.
- Tighten the clamps of the upper frame lightly.
- Do the final tightening in connection with the approach light adjustment.

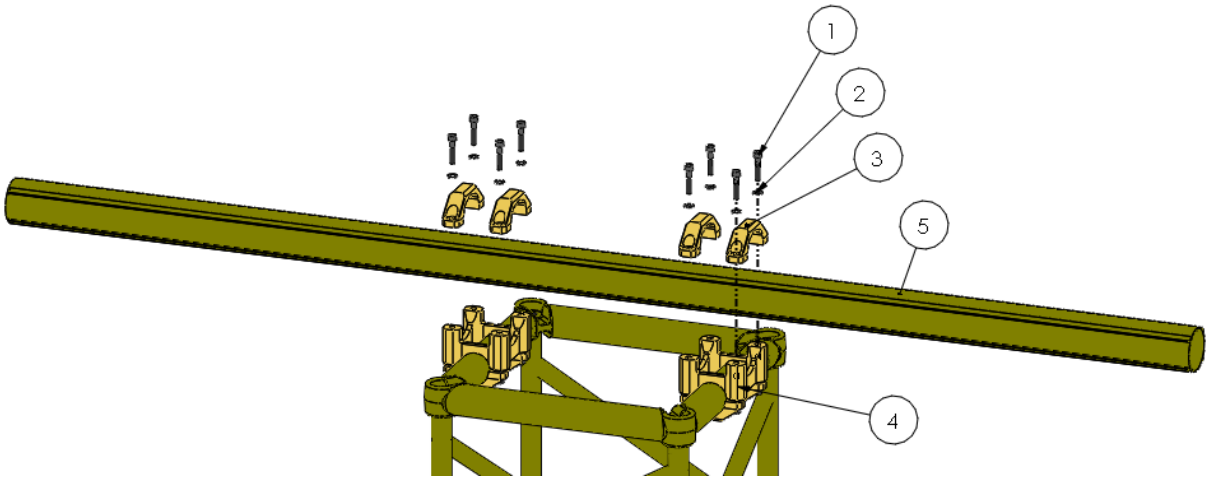


FIGURE 21. TOP FRAME, CLAMP AND CROSS BAR TUBE

No.	Part	Size	Qty
1	Allen Screw	M8 x 40 mm	8
2	Washer	M8, DIN 125	8
3	Clamp crossbow	Ø51 and ø72 mm	2+2
4	Clamp frame	-	2
5	Cross bar tube with ribs	Ø72 mm	1

TABLE 14. PARTS FOR MOUNTING CROSS BAR TUBE

5.1.4 WORK INSTRUCTIONS FOR INSTALLATION OF STRUT ARM PAIR

Do the preliminary installation of the adjustment tube clamps in connection with installation of the strut arms. See ”Installation of approach lights”.

- Attach the upper ends of the strut arms to the cross bar tube with the crossbow clamps. Open the clamp by removing the hex socket head screws, check that the clamps have a rubber lining on the inside and fasten the clamp around the cross bar tube.
- Place the horizontal supports carefully to opposite sides of the lattice section. The distance from the top of the mast should be approximately the same as the distance of the strut arm top clamps from the mast centre line. This way the strut arms are set in a 45° angle. Use green plastic clamps for fastening. Do not tighten the fastening screws of the clamps.
- Fit the lower ends of the strut arms to their positions in the horizontal support. Place bonded washers against the glass fibre profiles.

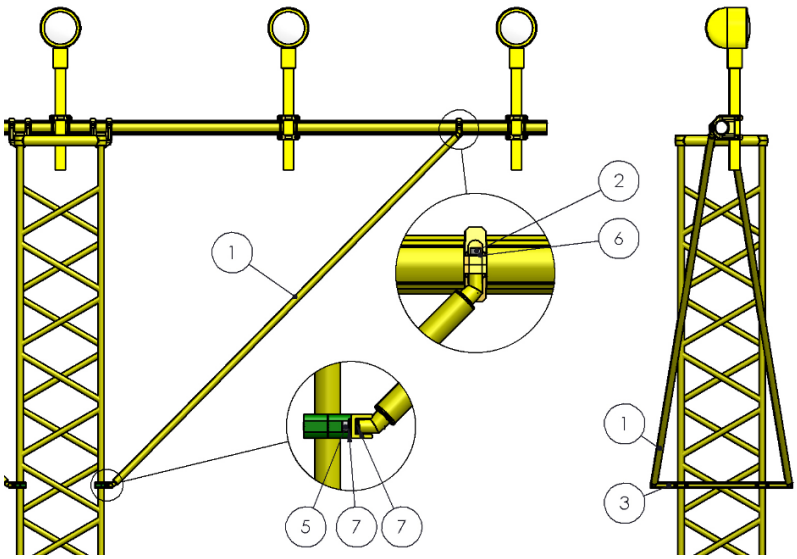


FIGURE 22. INSTALLATION OF STRUT ARMS

No.	Part	Size	Qty
1	Strut arm	-	2+2
2	Allen screw	M8 x 45 mm	2+2
3	Horizontal support	-	1+1
4	Clamp with rubber lining	Ø72 mm	2+2
5	Allen screw	M8 x 35 mm	2+2
6	Washer	M8	2+2
7	Bonded washer	Ø19/8,7	4+4

TABLE 15. PARTS FOR STRUT ARMS INSTALLATION

- The quantities given in the parts list above are needed for mounting the strut arms to one mast.

5.1.5 FITTING STRUT ARMS TO SHORT MASTS

If the mast with strut arms is short and the strut arms cannot be mounted at a normal angle of 45°, they can be mounted at an angle of approximately 60° according to the illustration below. **60° strut arms will be delivered preassembled from the factory.**

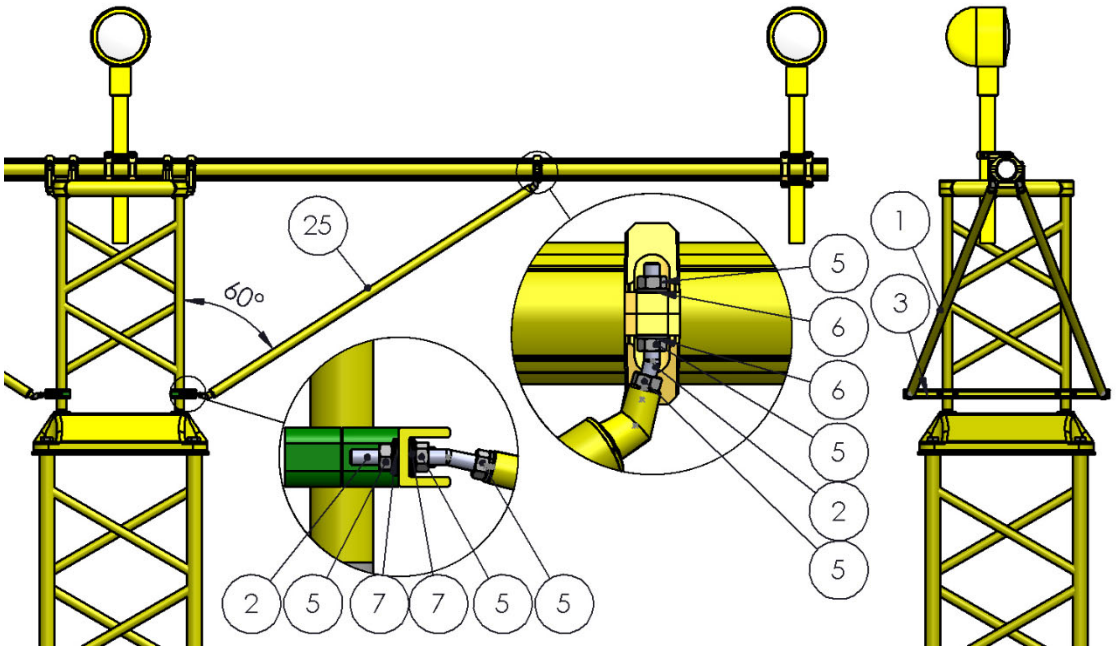


FIGURE 23. FITTING STRUT ARMS TO A SHORT MAST

No.	Part	Size	Qty
1	Strut arm	-	2+2
2	Angle screw	M8	4+4
3	Horizontal support	-	1+1
4	Clamp with rubber lining	Ø72 mm	2+2
5	Lock nut	M8	12+12
6	Washer	M8	8+8
7	Bonded washer	Ø19/8,7	4+4

TABLE 16. PARTS FOR INSTALLATION OF STRUT ARMS TO A SHORT MAST

- The quantities given in the parts list above are needed for installation of strut arms to one mast.
- When mounting strut arms at an angle of 60°, use angle screws and M8 nuts instead of M8 screws.

5.2 INSTALLATION OF APPROACH LIGHTS

5.2.1 EQUIPMENT NEEDED FOR INSTALLATION OF APPROACH LIGHTS

Action	Tool	Size
Final tightening of screws	Torque wrench	M=20 Nm
Clamp, tightening of M8 screw	Allen key	S=6 mm
Adjustment tube clamp, M8 allen screw	Allen key	S=6 mm
Strut arm clamp, tightening of M8 screw	Allen key	S=6 mm

TABLE 17. TOOLS NEEDED FOR INSTALLATION OF APPROACH LIGHTS

Object	Screw size	Torque
Clamp, cross bar side	M8	13 Nm
Clamp, light adjustment tube side	M8	13 Nm
Strut arm clamp	M8	13 Nm

TABLE 18. TORQUE S APPLIED IN THE INSTALLATION OF APPROACH LIGHTS

5.2.2 LIGHT ADJUSTMENT TUBE CLAMPS

The adjustment tube clamps are the same as the cross bar tube clamps. Install adjustment tube clamps in connection with the installation of strut arms.

- Fix the adjustment tube clamps to their positions and tighten them lightly.

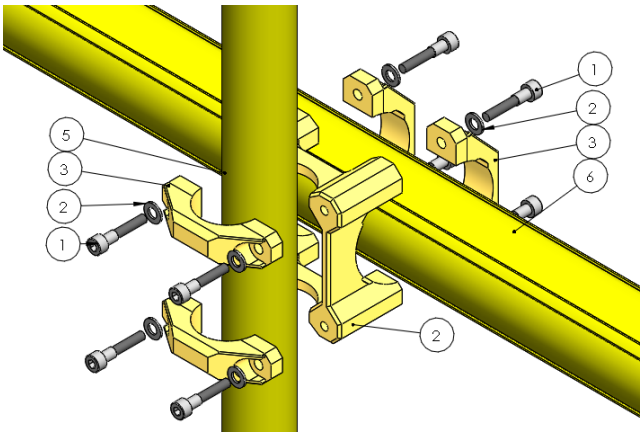


FIGURE 24. ADJUSTMENT TUBE MOUNTING

No.	Part	Size	Qty
1	Allen screw	M8 x 40 mm	8
2	Washer	M8 DIN 125	8
3	Crossbow of clamp	Ø51 and Ø72	2+2
4	Clamp frame	-	1
5	Light adjustment tube	Ø51 x L1	n
6	Cross bar tube, with ribs	Ø72 mm x L2	1

TABLE 19. PARTS FOR MOUNTING LIGHT ADJUSTMENT TUBE

5.2.3 FITTING AND ADJUSTMENT OF APPROACH LIGHTS

- Fit the approach lights to their sleeves.
- Check the light height and the light spacing in the mast list.
- Measure light height from the mast base.
- Adjust the light height roughly. The final adjustment will be done on the erection site by using an optic device.
- Check also the light spacing in the mast list.
- Measure the distances between lights.
- Adjust the light spacing and the position of the centre line of lights roughly. The final adjustment will be done at the erection site by using an optic device.
- Tighten all screws of the approach lights and strut arms.

5.3 INSTALLATION OF ELECTRICAL WIRES

5.3.1 EQUIPMENT NEEDED FOR INSTALLATION OF ELECTRICAL WIRES

Object	Screw size	Torque
Wiring of cross bar tubes	Rubber cable	VSB 2 x 2,5 mm
Wiring of lattice section	Conduct wire or lead	2,5 mm^2
Cover tube for cross bar	Plastic tube, UV-protected	Ø25 mm
Cover tube of lattice section	Plastic tube, UV-protected	Ø25–50 mm
Cover tube over joint element and base frame	Flexible plastic tube, UV-protected	Ø25–50 mm
Fastening of cover tubes	UV-protected plastic straps	Suitable
Cover tube from transformer housing to foundation	Plastic tube	IR 65
Connection between wires	Secondary connector	KD 501, 502 or 503R
Sealing of cover tubes in the bottom section	Sealing compound or tape	

TABLE 20. EQUIPMENT NEEDED FOR INSTALLATION OF ELECTRICAL WIRES

5.3.2 WORK INSTRUCTION FOR WIRING

ICAO's recommendation for wiring of an approach mast encourages the designer to provide points of disconnection for the wires to ensure that segmentation is not hindered in case of a collision. The wiring method presented in this document satisfies that recommendation and has been found practical. These cable installation instructions can be considered a recommendation. Installation can be carried out also by using another method.

Wiring on the foundation site

- Place the cable duct tubes between the transformer housing and the foundation prior to casting the foundation. Recommended duct tube IR 65. The cable conduit is drawn under the ground from the transformer housing through the foundation up to and as close as possible to either inside corner of the base plate that is facing the felling direction of the mast.

- Pass cables from the transformer housing to the foundation.

Wiring to be carried out on the mast assembly site

It is recommended to wire the mast to the greatest possible extent on the mast assembly site. Only the connection of the leads in the mast to the cables drawn from the transformer housing will be carried out on the erection site.

- Draw a rubber cable (recommendation: VSB 2x2,5) from the joint be-tween the lattice section and the cross bar tube to all approach lights. Fix the rubber cables to the cross bar tube either directly or inside ø 25 mm cover tube with UV-protected plastic straps. Fix the rubber cables only to the cross bar tube, and not at all to the lattice section.
- Connect the rubber cable leads to the approach lights. Fit the rubber cable leads at the other end of the rubber cable with the KD-connectors.
- Fix a UV-protected cover tube to the lattice sections. Choose an appropriate size ø25–50 mm of the cover tube according to the quantity of cables. Fix with UV-protected plastic straps to the leg beams.
- Pass by the joint element with a UV-protected, flexible cover tube. Use matching cover tube joints in the connection between cover tubes.
- Fix a similar flexible cover tube also to the lower end of the cover tube. The flexible tube will be connected later to the cover tube coming from the foundation. Leave enough length to the flexible cover tube to compensate tilting of the mast.
- Pass the leads (recommendation: MK 2,5) through the cover tube. Leave extra length to the leads for felling of the mast. Connect the upper ends of the leads to the KD connectors, which are connected to the leads of the rubber cable. Connect the lower ends of the leads to the KD connectors, which will be connected later to the cable passed through the foundation.

5.3.3 EXAMPLE OF WIRING ROUTES

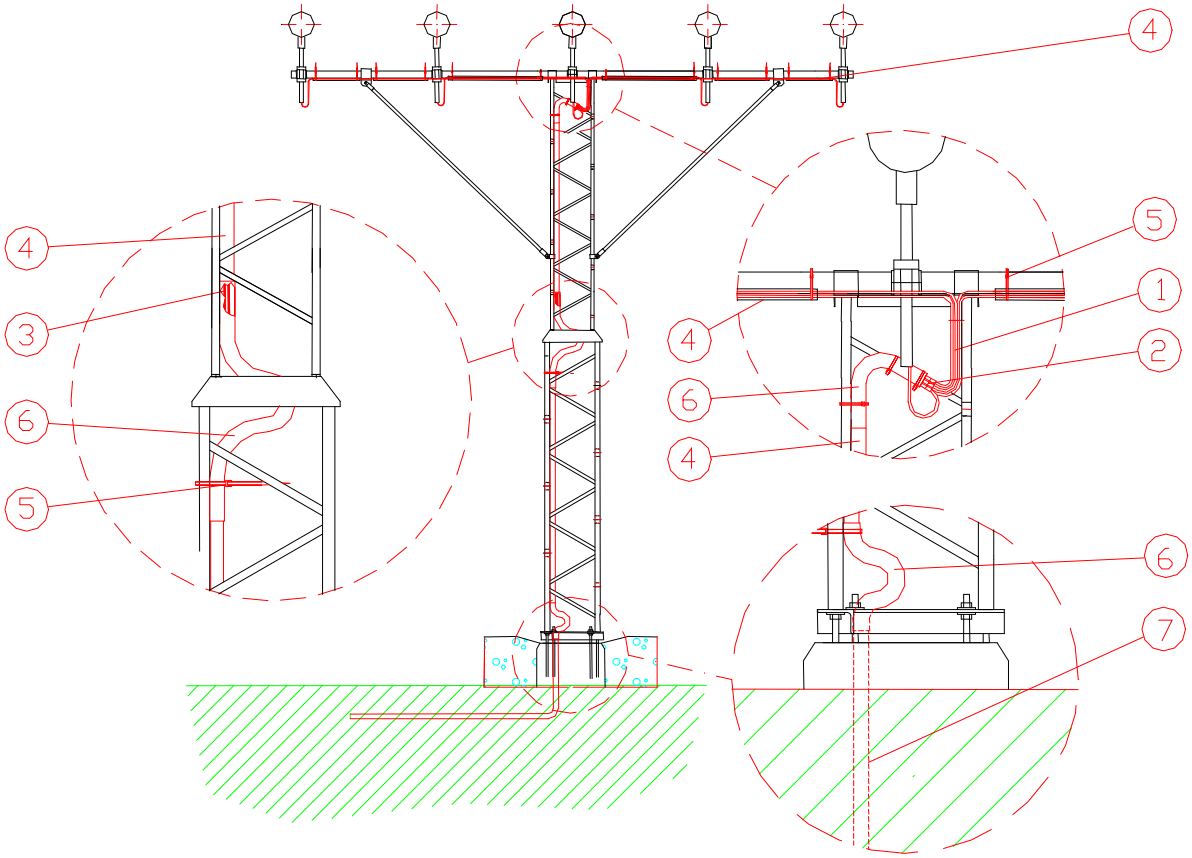


FIGURE 25. WIRING OF A MAST

No.	Part	Size
1	Rubber cable	VSB 2x2,5 mm
2	Secondary connector	KD 501, 502 or 503-R
3	Conduct wire	2,5 mm
4	UV-protected plastic tube	Ø25-50 mm
5	UV-protected plastic straps	-
6	UV-protected flexible plastic tube	Ø25-50
7	Plastic tube	IR 65

TABLE 21. PART LIST OF FIGURE 24 "WIRING OF A MAST"

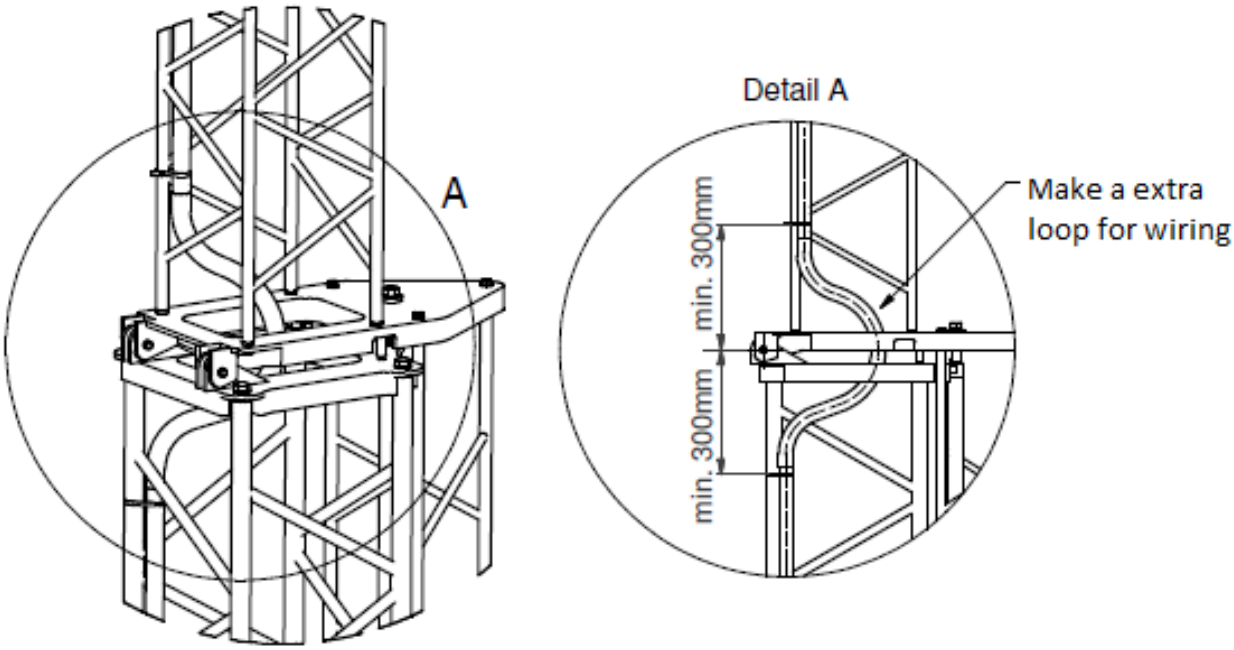


FIGURE 26. WIRING OF CENTRE HINGE

- IR 65 tube is similar to a drainage pipe, but there are no holes in it.

- Use only leads, not rubber cable, in the wiring of the lattice part. The lattice part is frangible and will break safely in case of an aircraft impact, and this frangibility must not be compromised by using too strong cables.
- The cover tubes will be fitted to the vertical leg beams. Avoid fitting to the diagonal beams.
- Provide the upper and lower ends of the leads with secondary connections, which will be detached in case of an impact.
- Seal the joint between the IR65 tube and the lower flexible plastic tube to get it waterproof.

6. MOUNTING BASE FRAME TO MAST

6.1 MOUNTING HINGED AND FIXED BASE FRAME

The hinged base frame is suitable for both 400 mm and 500 mm mast modules. Fixed base frames are only suitable to selected mast size. The holes of the foundation bolts in the base frame are slightly oversized. This enables the necessary adjustment of deflection ± 0,5° of the masts.

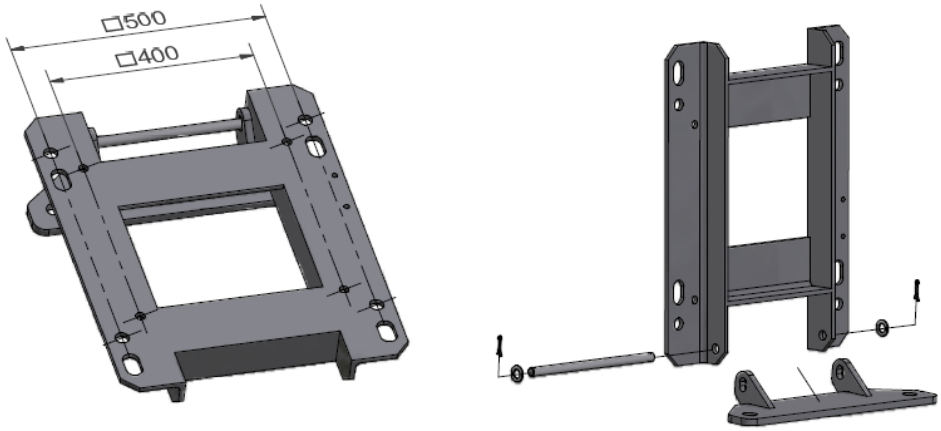


FIGURE 27. HINGED BASE FRMAE

- Detach the hinge pin and the lower half of the base frame as illustrated.

- Make sure not to separate the base frame halves, because they have been matched together during frame assembly.

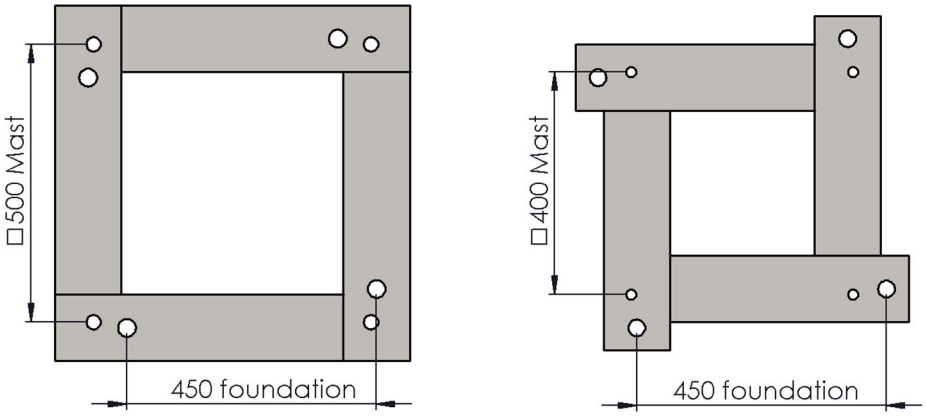


FIGURE 28. FIXED BASE FRAMES

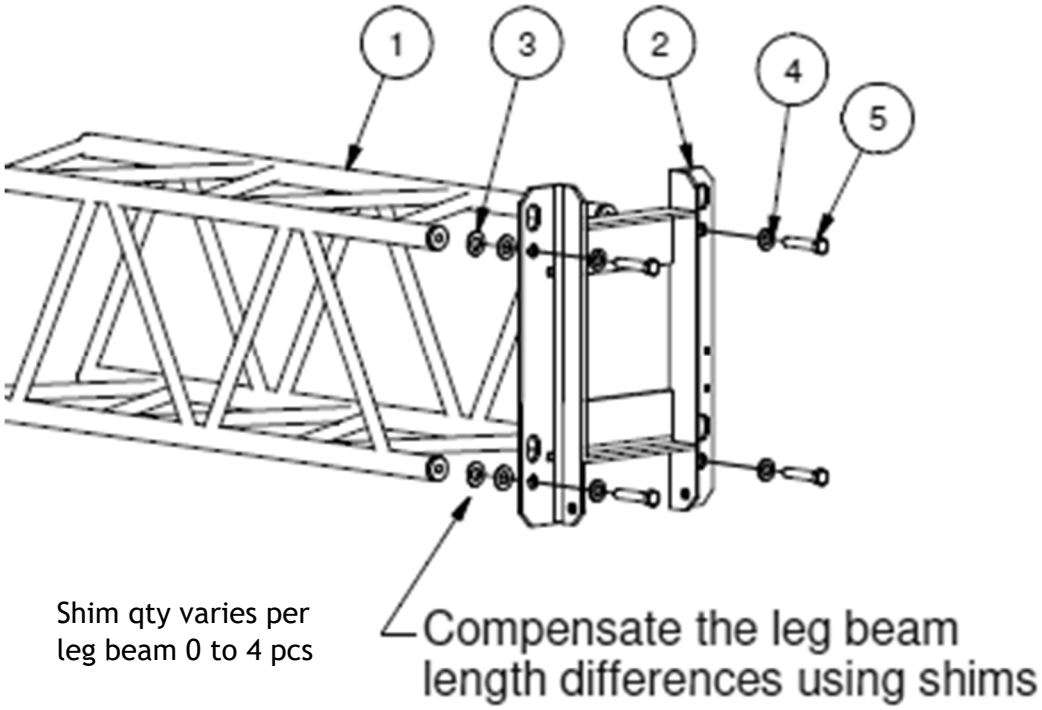


FIGURE 29. MOUNTING OF BASE FRAME

- Detach the bolts from lower end of the mast and fasten the base frame to the mast.

No.	Part name	Size/Model/ref.	Qty.
L400 mast			
1	Mast module	400 mm	1
2	Base Frame	fixed / hinged	1
3	Shim	Ø32/17x0.5	n
4	Washer	M16	4
5	Hex screw	M16 x 40 mm	4
L500 mast			
1	Mast module	500 mm	
2	Base Frame	fixed / hinged	1
3	Shim	Ø50/24x0.5	n
4	Washer	M24	4
5	Hex screw	M24 x 50 mm	4

TABLE 22. LIST OF BASE FRAME PARTS

- Tighten the screws of the base frame to their torque setting. Use a hook wrench to apply torque against tightening.

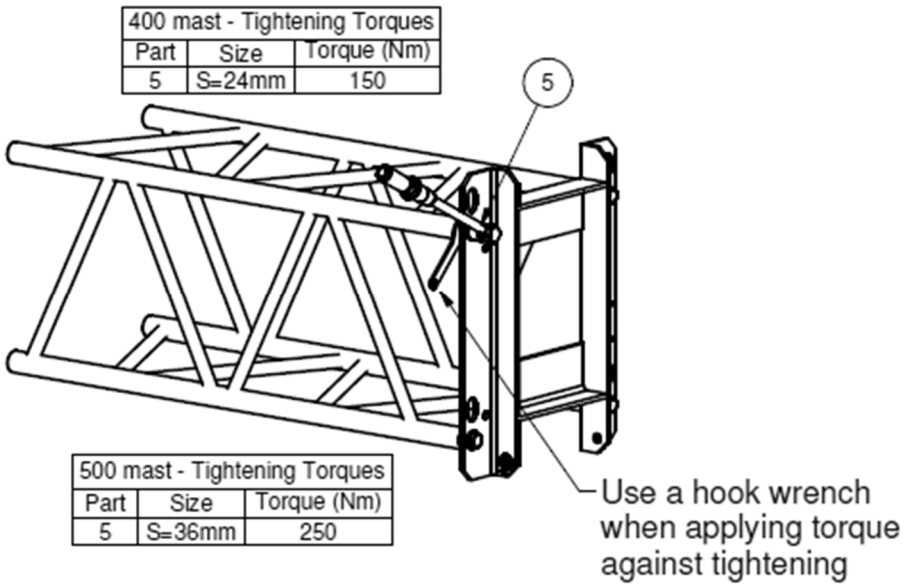


FIGURE 30. TIGHTENING OF BASE FRAME SCREWS

i	• The mass of a hinged base frame is approximately 50 kg. • The mass of a fixed base frames is approximately 25-30kg.
☞	• Shims must be used in order to distribute the tightening load equally between all leg beams. Leg beams shall in no case be tightened to the level of the base frame by force. The diagonal beams do not sustain such stress; they are designed to be frangible.

7. MOUNTING AND ERECTING THE MAST

7.1 PREPARATION OF FOUNDATION BEFORE ERECTION OF A MAST

7.1.1 PREPARATION FOR HINGED BASE FOUNDATION

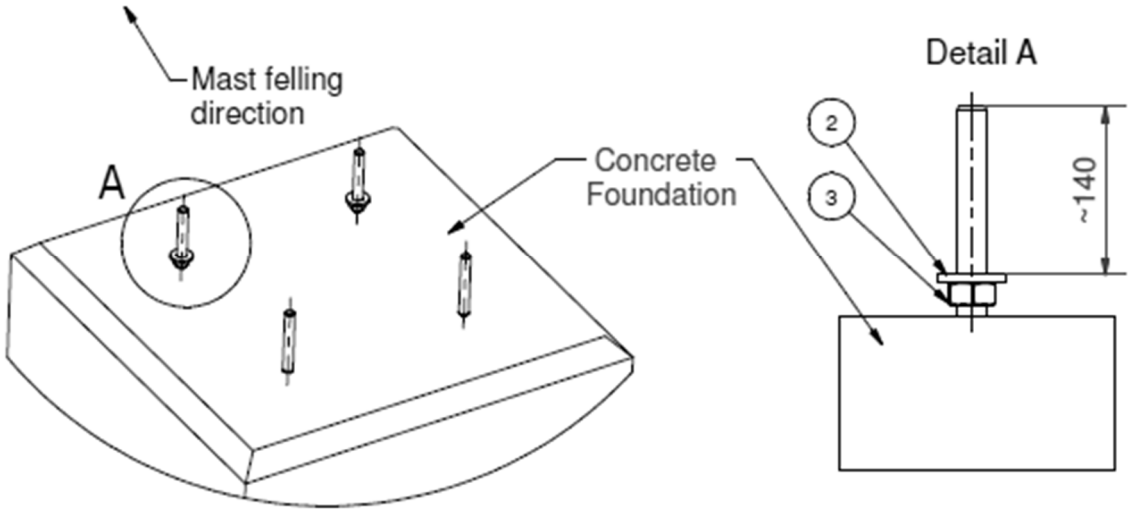


FIGURE 31. INSTALLING NUTS FOR HINGED BASE PLATE

- Remove protective tapes from foundation bolts and install base nuts for the bottom hinge plate.

No.	Part	Size	Qty
1	Base frame		1
2	Washer	Ø56/25x6	4
3	Nut	M24	8
4	Threaded Washer	Ø60/24x6	4

TABLE 23. LIST OF HINGED BASE FRAME CONNECTION PARTS

- Check the correct felling direction of the mast.

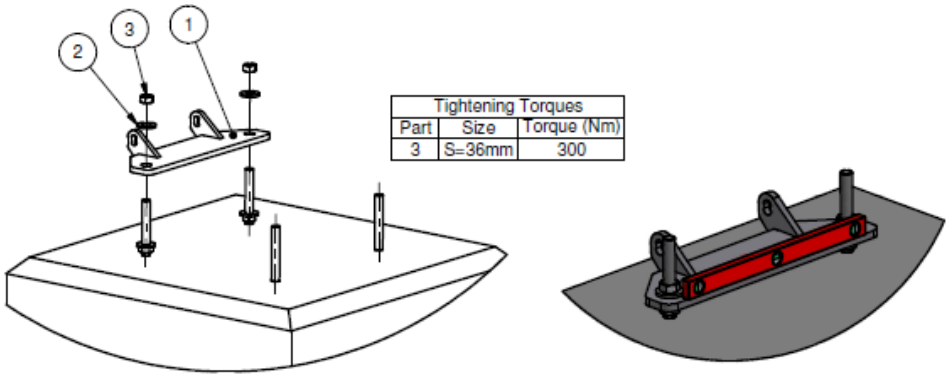


FIGURE 32. MOUNTING AND ALIGNING THE BOTTOM HINGE PLATE

- Mount the bottom hinge plate and check after tightening that the plate is horizontal.

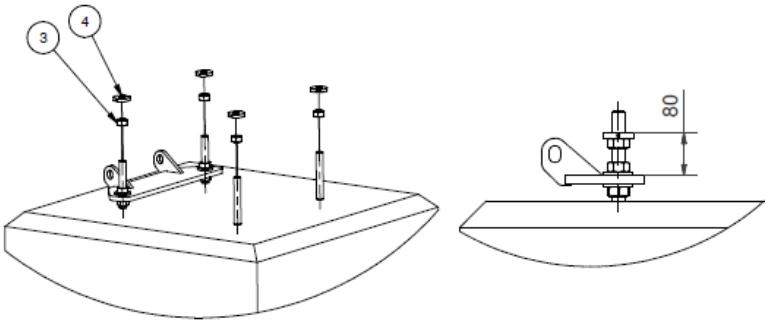


FIGURE 33. INSTALLING NUTS FOR THE TOP PART OF HINGED BASE FRAME

- Add nuts and threaded washers to the foundation bolts as illustrated above.

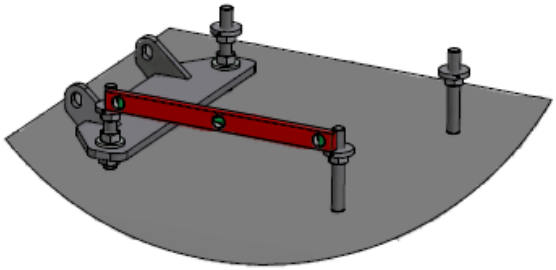


FIGURE 34. ALIGNING THE TOP WASHERS

- Adjust all washers to the same level using water level.

- Make sure not to separate the base frame halves, because they have been fitted together during initial frame assembly.

7.1.2 PREPARATION FOR FIXED BASE FOUNDTAION

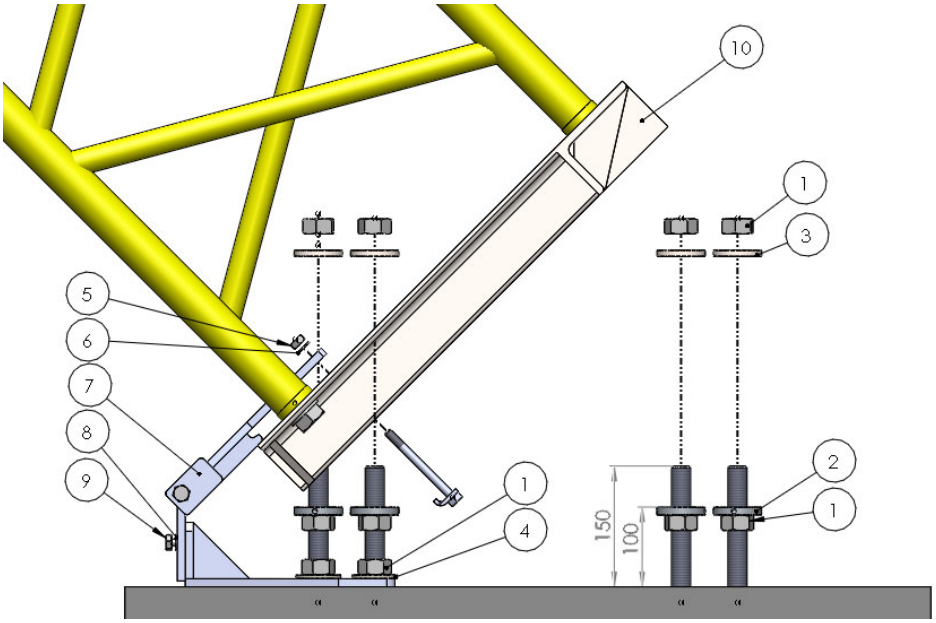


FIGURE 35. PREPARATION OF FIXED BASE FRAME WITH HINGE TOOL

No.	Part	Size	Qty
1	Hex nut	M20 or M24	4+4+2
2	Threaded washer for L400 or L500	Ø60/M20 or Ø60/M24	4
3	Washer for L400 or L500	Ø60/20 mm or Ø60/24 mm	4
4	Washer	M20 or M24	2
5	Hex nut	M10	2
6	Washer	M10 DIN 125	2
7	Hinge tool (removable)	L400 / L500	1
8	Washer	M10 DIN 125	2
9	Hex screw	M10x25 DIN933	2
10	Fixed Base frame	L400 / L500	1

TABLE 24LIST OF FIXED BASE FRAME INSTALLATION PARTS

- Assemble nuts and washer for hinge tool. [1,4].
- Install nuts and threaded washers for base frame [1,2].
- Adjust and check horizontal level of threaded washers.

7.2 MOVING LATTICE MAST TO ITS FINAL POSITION

When mast modules and parts have been joined to each other, the mast will be moved from the assembly site to its final position for erection. Place the mast in a horizontal position beside its concrete foundation to wait for erection.

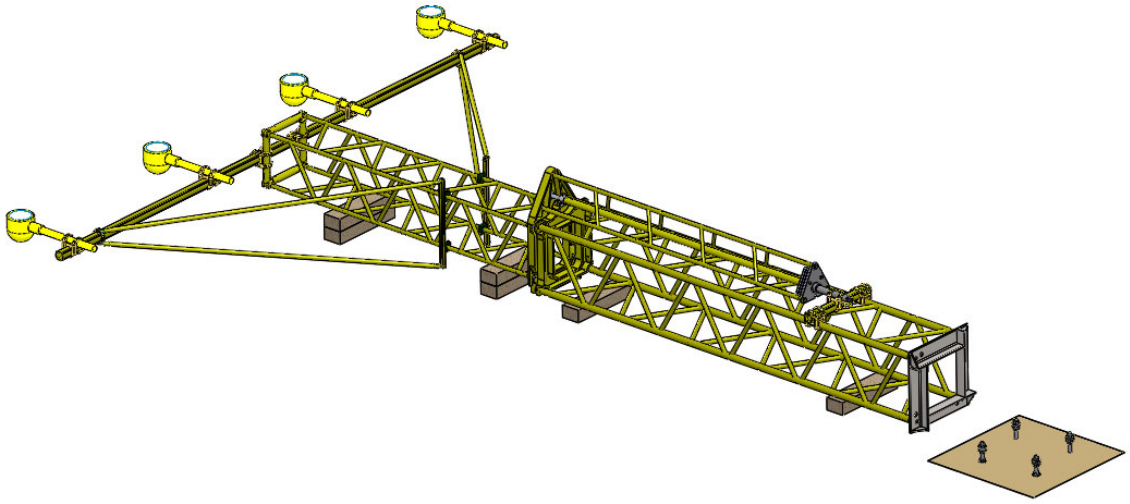


FIGURE 36. MAST WAITING FOR ERECTION

- Check that the mast sections have not been damaged during any previous handling.
- Lift the mast from the top frame, joint element, base frame or leg beams. Never lift the mast from the diagonal beams.

7.3 WORK INSTRUCTIONS FOR MANUAL ERECTION OF A MAST

7.3.1 JOINING OF HINGED BASE MAST TO FOUNDATION

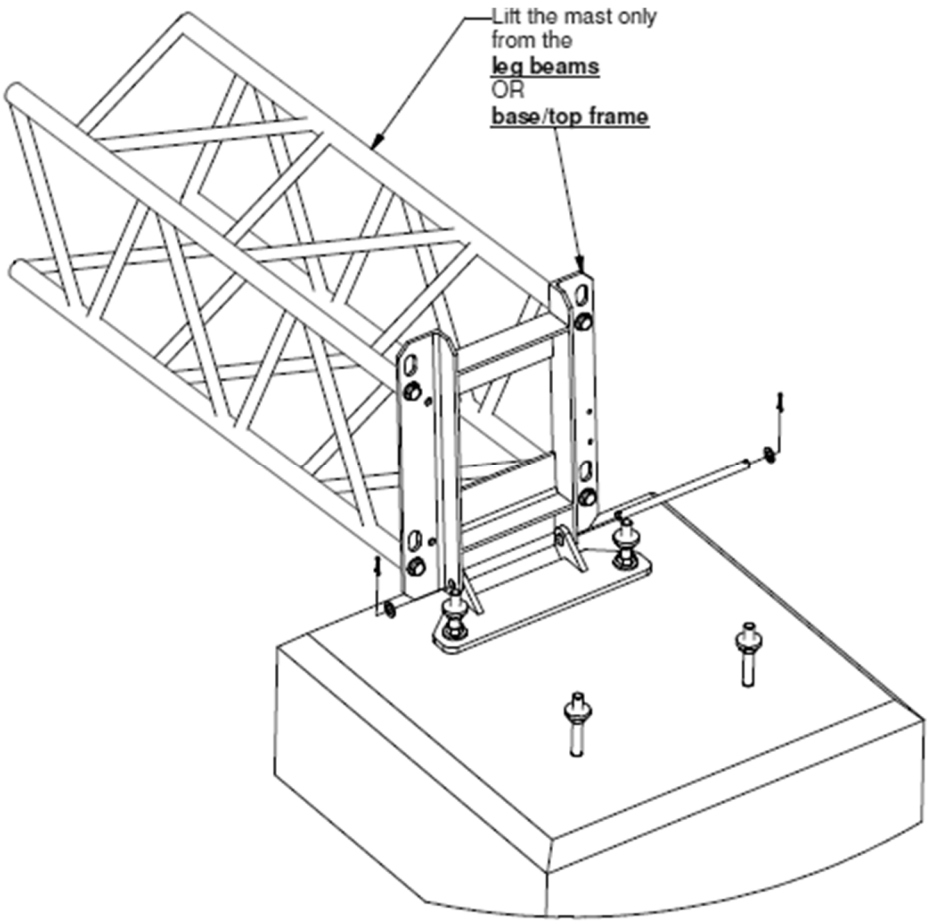


FIGURE 37. JOINING OF MAST TO BASE FRAME

- Move mast module to assembly position so that the halves of the hinged base plate can be joined.
- Insert hinge pin, add washers and cotter pins to both ends.

- Verify before the erection that the masts have not been damaged during handling.

7.3.2 JOINING OF FIXED BASE MAST TO FOUNDATION WITH HINGE TOOL

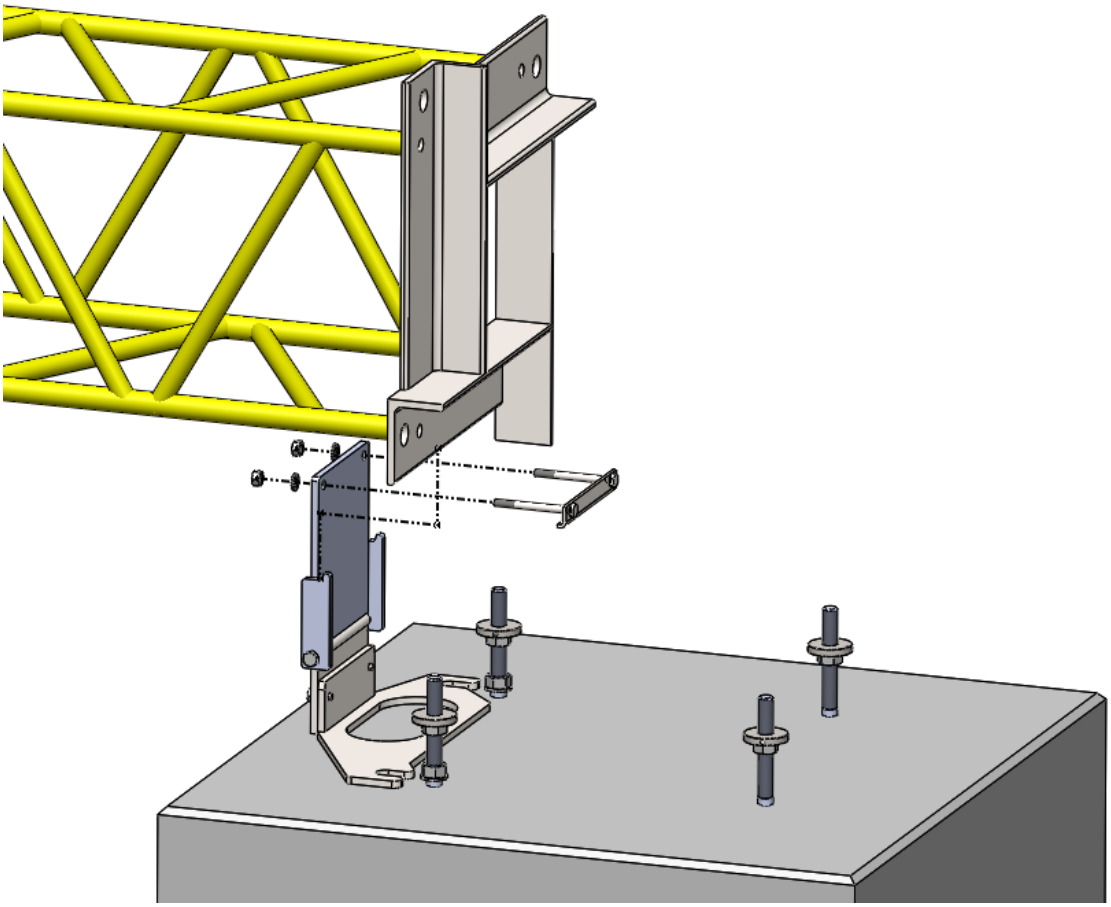


FIGURE 38. MOUNTING OF HINGE TOOL

- Install hinge tool to foundation bolts, tighten nuts.
- Loosen hinge tool's M10 screws.
- Attach mast with fixed base frame to hinge tool.
- Tighten hinge tool's M10 screws.

- Verify before the erection that the masts have not been damaged during handling.

7.3.3 MANUAL ERECTION OF MAST

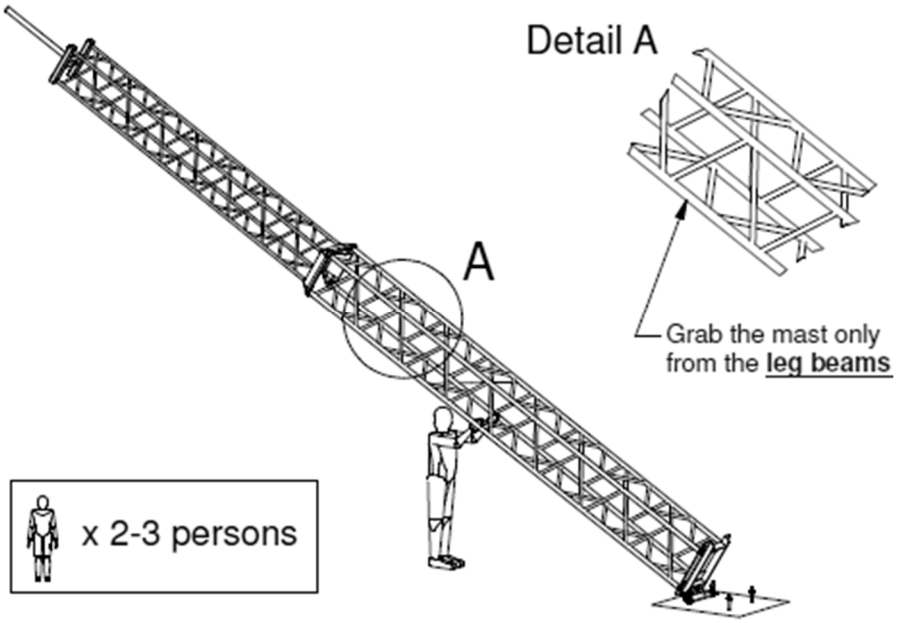


FIGURE 39. MANUAL ERECTION OF A MAST

- Erect the mast carefully by hand and tighten the nuts lightly.

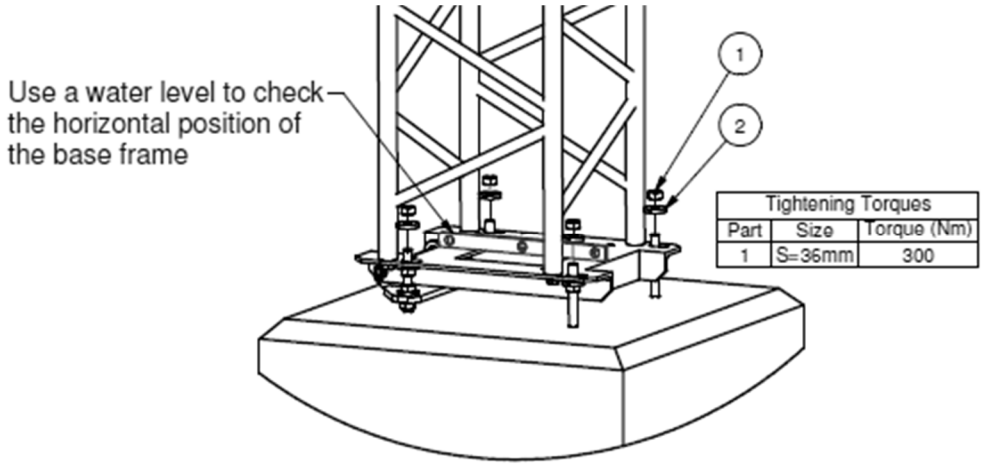


FIGURE 40. INSTALLING FASTENING NUTS

No.	Part	Size	Qty
1	Nut	M24 or M20	4
2	Washer	Ø60/24x6 or Ø60/20x6	4

TABLE 25.LIST OF CONNECTION PARTS

- Connect electrical wires, take into consideration the supplementary cable length required by lowering and raising of the mast.

i
- Use a water level to verify the vertical position of the mast.
- Use an optic device to measure the adjustment of alignment of the mast.

7.4 Work Instructions for Erecting a Mast With a Crane

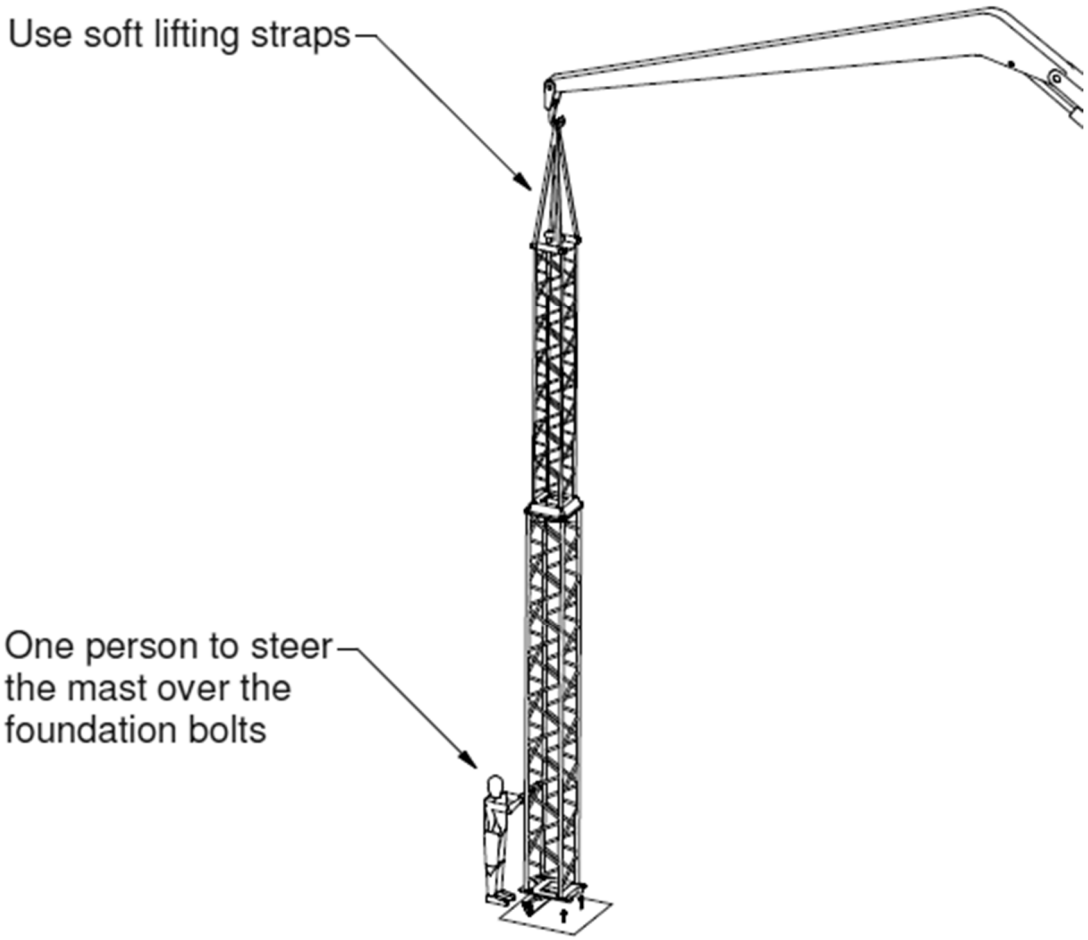


FIGURE 41. ERECTING A MAST WITH CRANE

- Fasten soft hoisting straps to the top frame of the mast.
- Lift the mast from the ground and lower down on the foundation steering the base frame in the correct position over the foundation bolts. Tighten the nuts lightly.

- Verify before the erection that the masts have not been damaged during handling.

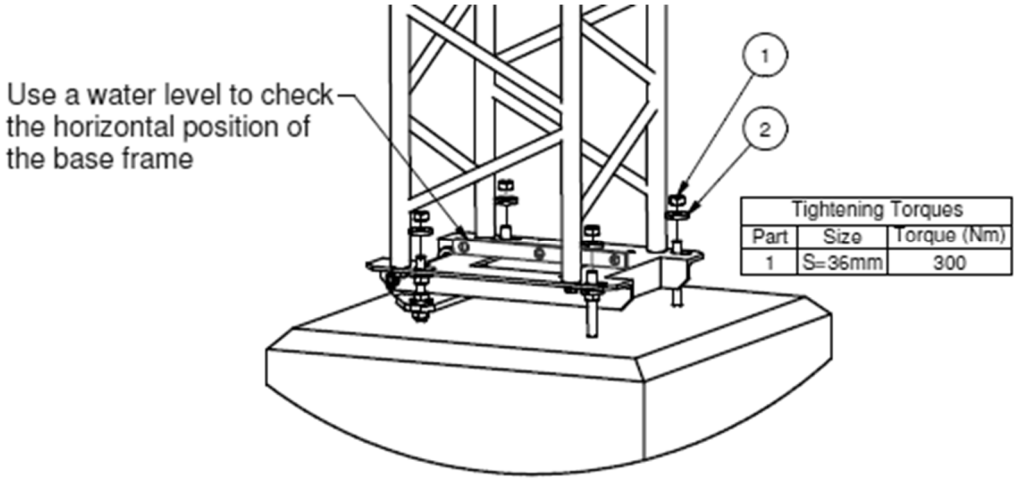


FIGURE 42. INSTALLATION FASTENING NUTS

No.	Part	Size	Qty
1	Nut	M24 or M20	4
2	Washer	Ø60/24x6 or Ø60/20x6	4

TABLE 26. LIST OF CONNECTION PARTS

- Connect electrical wires, take into consideration the supplementary cable length required by lowering and raising of the mast.

- Use a water level to verify the vertical position of the mast.
- Use an optic device to measure the adjustment of alignment of the mast.

8. TILTING AND MAINTENANCE OF LATTICE MASTS

An Exel lattice mast is normally service and maintenance free. For servicing the approach lights, the mast can be tilted, or the servicing is done from the basket of an access platform. Please follow the instructions of the instrument supplier.

8.1 REGULAR MAINTENANCE

After six months of installation tightening torques of mast connections should be checked as shown in chapter 4 of this manual. It is also recommended to check masts for possible issues every two years.

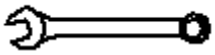
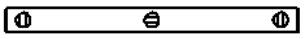
Most important parts to check:

- Base frame connections to foundation bolts
- Base frame connections to mast module
- Lower mast module connection to centre hinge or joining element
- Upper mast module connection to centre hinge or joining element
- Clamps of cross bar tubes
- Visual check for cracks on tubes. They can most likely be found at the bottom of lattice modules.

8.2 TILTING OF A BASE HINGED LATTICE MAST

Depending on the mast height, 2 – 4 persons are needed for lowering and raising the mast.

8.2.1 REQUIRED EQUIPMENT AND TOOLS

- Fork spanners  or adjustable wrench
- Torque wrench set
- Water level 
- Optic device
- Wooden rest (to support the mast when lowered)

Action	Tool	Size
Nuts of foundation bolts, opening/tightening	2 x Fork spanner	S=36 mm
Lock screws of base frame, opening / tightening	--:--	S=30 mm
Resting the mast when lowered	Wooden rest	
Final tightening of screws	Torque wrench set	
Adjustment of upright position of mast	Water level	
Adjustment of the alignment	Optic device	

TABLE 27. TOOLS NEEDED FOR LOWERING AND RAISING A BASE HINGED MAST

8.2.2 TILTING DOWN THE BASE HINGED LATTICE MAST

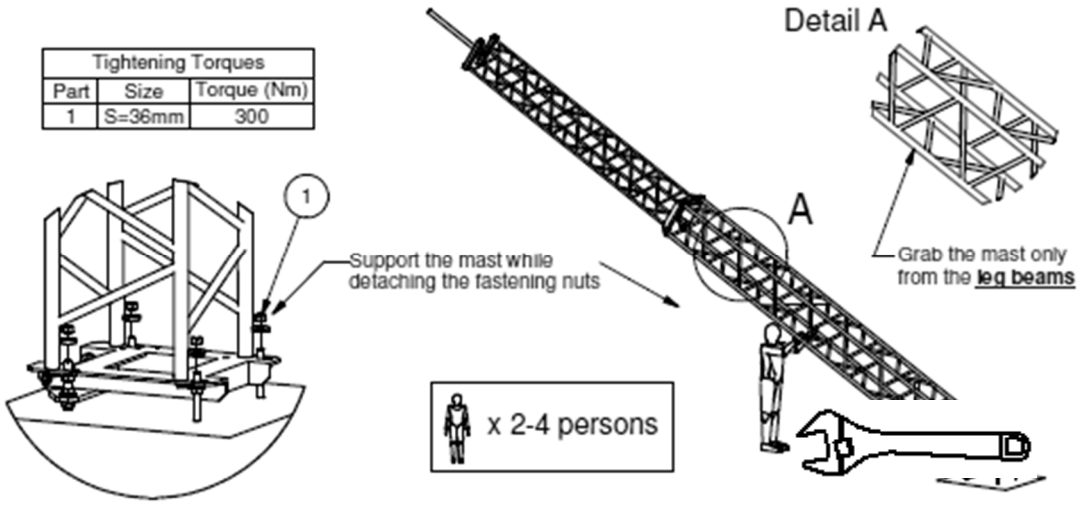


FIGURE 43. TILTING THE MAST FROM THE BASE

- Check that no obstacles exist in the felling area.

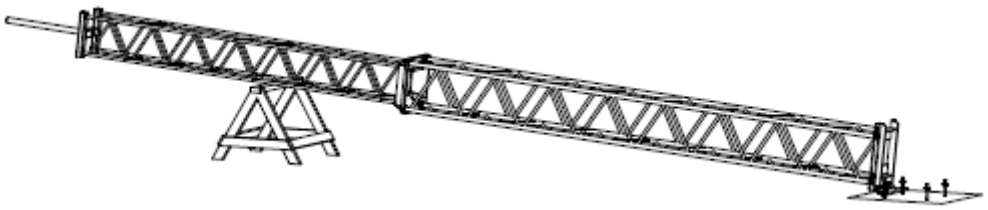


FIGURE 44. SUPPORTING THE MAST DURING MAINTENANCE

8.2.3 TILTING UP THE MAST DURING MAINTENANCE

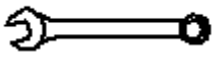
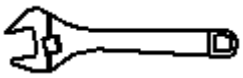
- Raise the mast by hand, lift only from the leg beams of the mast.
- Check with a water level that the mast is vertical and tighten the fastening nuts to their torque setting.

	• Observe especially that the mast base does not damage the anchor bolt threads during lowering/raising of the mast.
	• See the previous instructions ”Work instruction for erection of lattice mast” for more detailed instructions related to erection of the mast.

8.3 TILTING A CENTR HINGED LATTICE MAST

Exel centre hinged mast is made very service friendly. One person can do the lowering and raising of the mast.

8.3.1 REQUIRED EQUIPMENT AND TOOLS

- Fork spanners  or adjustable wrench 
- Torque wrench set
- Allen keys 
- Electric screw machine (for Allen screws)
- Optic device

Action	Tool	Size
Releasing and tightening the locking of the centre hinge	Electric screw machine	
-:-	Allen key	6 mm
-:-	Fork spanner	S=30 mm
Lowering and raising of a mast	Rope	Ø11 mm
-:-	2 x Rope clamp	
-:-	Safety catch	
Adjustment of light height	Allen key	S=6 mm
Final tightening of locking arm clamp	Torque wrench	M=20 Nm
Final tightening of adjustment tube clamp	Allen key	S=6 mm
Adjustment of light angle	Optic device	

TABLE 28. TOOLS NEEDED FOR LOWERING AND RAISING A CENTRE HINGED MAST

8.3.2 TILTING DOWN THE CENTRE HINGED MAST

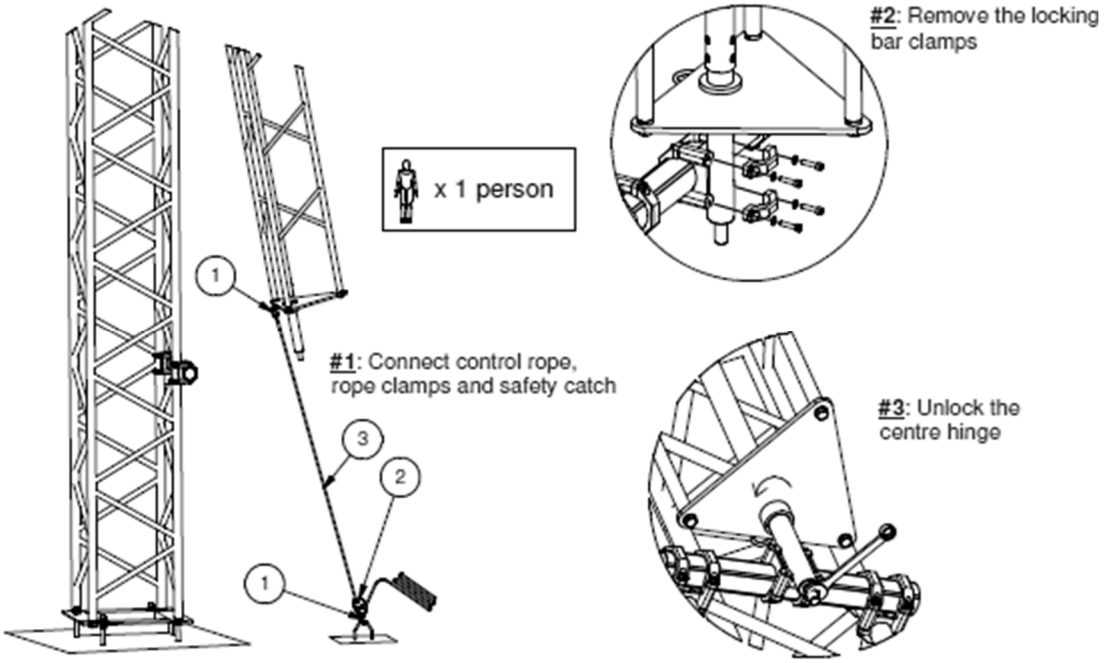


FIGURE 45. CONNECTING ROPE AND RELEASING TILTING ARM

No.	Part	Size
1	Rope clamp	Finch+ or similar
2	Safety catch	Finch+ or similar
3	Control rope	Ø11 mm

TABLE 29. EQUIPMENT REQUIRED FOR TILTING AND RAISING CENTRE HINGED MAST

- Tilt the top of the mast down with the tilting arm and the rope.

- Check that no obstacles exist in the felling area.
- If the lock bush is jammed you can direct a few light blows to the end of the torsion shaft.
- If the hinge is jammed you can direct a few blows to the base plate of the tilting arm. Do not try to force the hinge open by prying with the tilting arm.

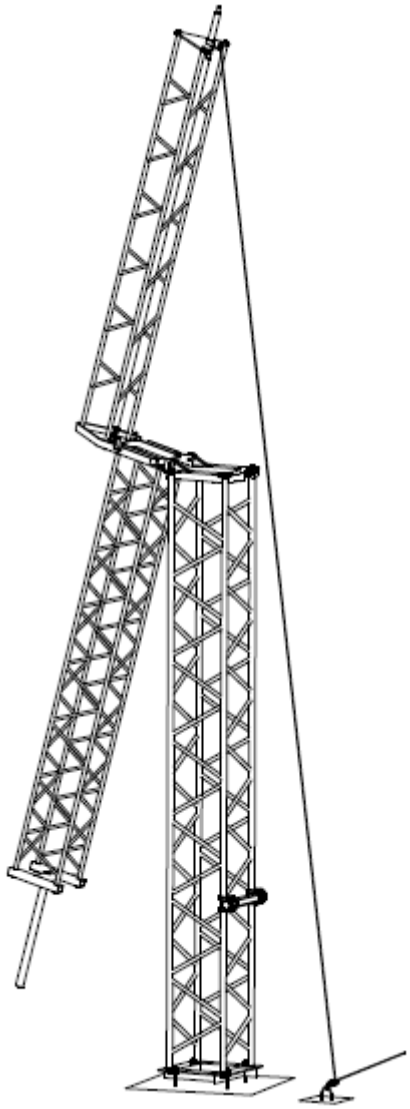


FIGURE 46. CENTRE HINGED MAST AT SERVICE POSITION

- The mast stops at the service position in a 15° angle from vertical.

- Set the rope in the safety catch to a loop that is either fixed to the ground or, for example, to the service vehicle.
- The mast movement must be slowed down with the control rope before the mechanical stop at the service position is reached.

8.3.3 TILTING UP THE CENTRE HINGED MAST

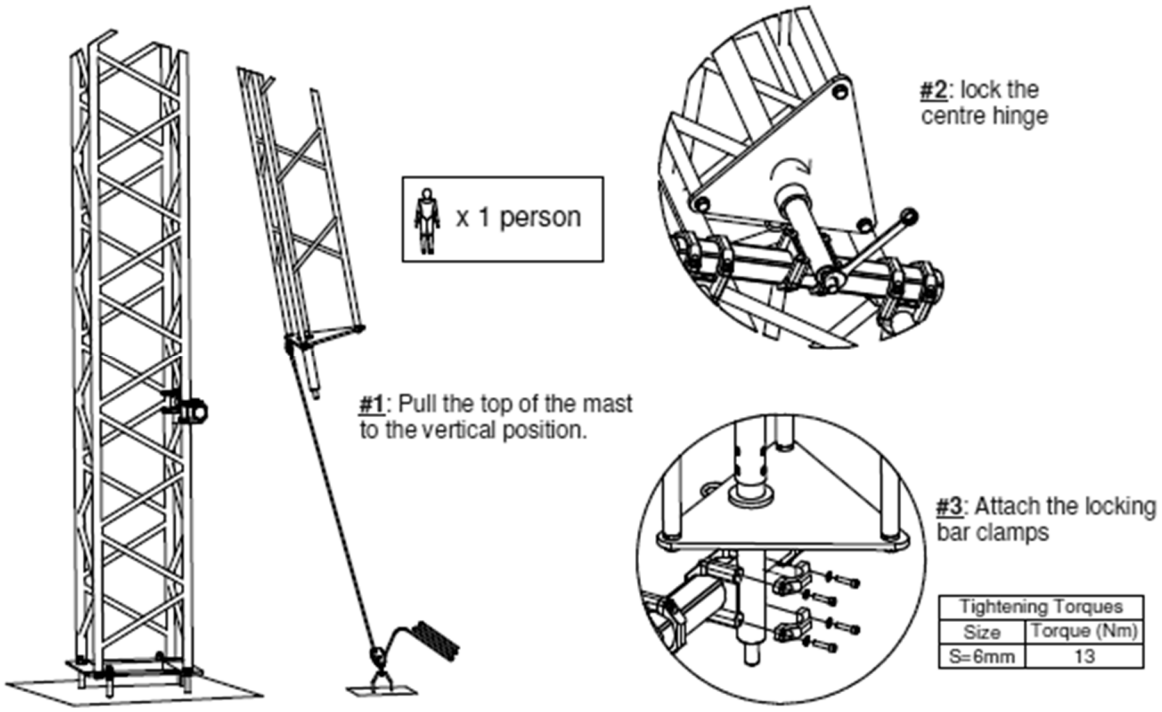


FIGURE 47. RAISING CENTRE HINGED MAST AND LOCKING TILTING ARM

- Pull the top of the mast back up to the vertical position and lock the centre hinge.
- After tightening locking arm clamps detach the control rope and its accessories.

i	• When the top section of the mast is tilted for service, the force required to pull the mast back up to the vertical position is higher. • The mast top and the tilting arm are just about in balance in the horizontal position, and the tilting arm becomes heavier when the top section of the mast is approaching the vertical position. • You will have to hold the rope to slow down the movement when the mast reaches the upright up.
☞	• Make sure that the hinge closes properly before turning the locking arm. • You can pull down on the tilting arm to close the hinge. The locking arm tube flexes a little. Do not overtighten.

8.4 REPAIR PAINTING

8.4.1 MATERIALS NEEDED FOR REPAIR PAINTING

Description	Quality / Color / Size
Sandpaper	Fine, 200-400
Acetone	
Paper or cloth towel	
Two-component polyurethane paint	Aviation yellow (RAL 1021 or NCS 0580-Y05R)
Brush	Width approximately 20 – 50 mm
Tape	Polypropylene, PP
Mixing stick	Wood, plastic etc.
Rubber gloves	

TABLE 30. MATERIALS NEEDED FOR REPAIR PAINTING OF LATTICE MASTS

8.4.2 WORK INSTRUCTIONS OF REPAIR PAINTING

- Clean all surfaces with sandpaper.
- Wipe the dust off with acetone and paper/towel.
- Mix the paint carefully. Follow the paint manufacturer's instructions.
- Brush the paint on the clean surface.

i	• Read the instructions of the paint manufacturer for painting conditions. • Recommended temperature during painting work: minimum 18° C
⚠	• Read and follow the manufacturer's safety instructions. • Wear safety glasses all the time. • Use rubber gloves all the time. • Wear a dust respirator filter when necessary. • Assure good ventilation. • Avoid skin contact. • Acetone is flammable.

8.5 GLASS FIBRE TUBE REPAIR

8.5.1 MATERIAL NEEDED FOR GLASS FIBRE TUBE REPAIR

Description	Quality / Color / Size
Sandpaper	Fine, 200-400
Acetone	
Paper or cloth towel	
Pre-accelerated Epoxy Vinyl Ester Resin (Component A)	Derakane 411-45/ (e.g. Ashland)
Hardener (Component B)	Butanox 50 (e.g. Nauryon)
Syringe	20 ml
Glass fibre mat reel	Reel B=35–50 mm For example Weight 425g/m^2 Ward 70 x 320 mm Weft 53 x 272 mm Plain weave, thickness 0,32
Two-component polyurethane paint	Aviation yellow (RAL 1021 or NCS 0580-Y05R)
Brush	Width approximately 20–50 mm
Tape	Polypropylene, PP
Mixing pots	PE/PP-plastic, 1litre
Mixing sticks	Wood, plastic etc.
Rubber gloves	

TABLE 31. MATERIALS NEEDED FOR GLASS FIBRE TUBE REPAIR

- Arrange the repair conditions as instructed by the resin/hardener producer.
- Recommended minimum temperature for repair and painting is +18° C

8.5.2 REPAIRING THE DAMAGE

Pre-treatment

- Remove dirt and old paint with acetone and paper.
- Abrade and clean the surfaces with sandpaper.
- Wipe off the dust with acetone and paper/towel.

Mixing the components

- Carefully read the manufacturer's instructions and follow them.
- Use a syringe and/or a scale to measure the quantities of different components.
- Do not mix more than 100 g at a time, you have only about 25 min to work.

Normal mixing ratio: $\frac{\text{Component A}}{\text{Component B}} = \frac{100g}{2g}$

Doing the repair

- Spread the mixed resin on the damaged area.
- Try to soak the damaged area with the resin.
- Wind glass fibre mat tightly around the damaged area spreading more resin over the mat at the same time. Make sure that the mat is fully soaked, this is to obtain as much strength as possible.
- Wind minimum of 2 full layers, 3-4 layers where possible. Direct the layers in 30-45˚ angle to each other.
- Finish the repair by winding polypropylene tape around the repaired area to squeeze air out and to penetrate the resin into the tube structure.

Hardening

- Let the resin cure in the instructed temperature for 24 hours.

Surface finishing

- Remove the polypropylene tape.
- Abrade the surface with sandpaper.
- Paint the repaired area as instructed earlier in this manual.

i	• The damage can be repaired if it is less than half of the circumference of the tube. • If the tube is fully broken, contact the representative of Exel Composites Plc.
⚠	• Read the manufacturer's safety instructions and follow them carefully. • Wear safety glasses all the time. • Use rubber gloves all the time. • Wear a dust respirator filter. • Assure good ventilation. • Avoid skin contact. • Acetone is flammable.

9. LISTS OF TABLES & APPENDICES

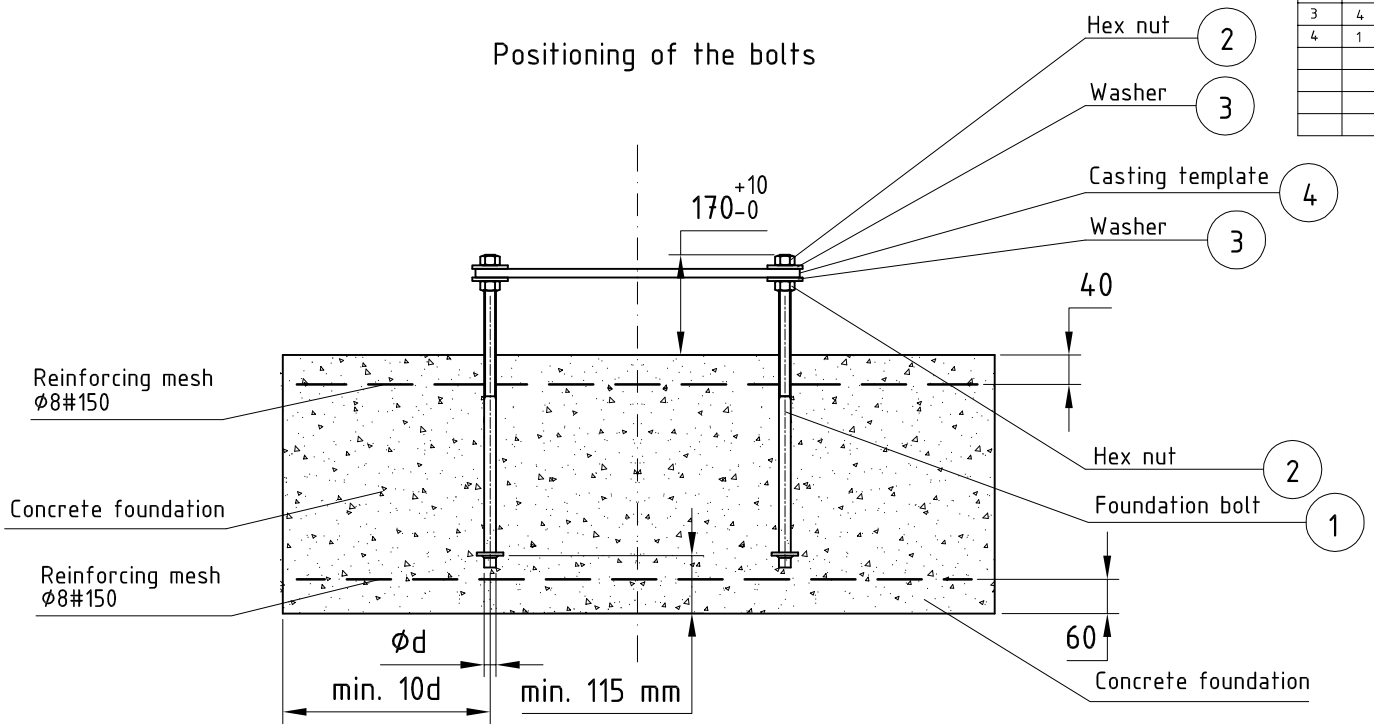
LIST OF TABLES

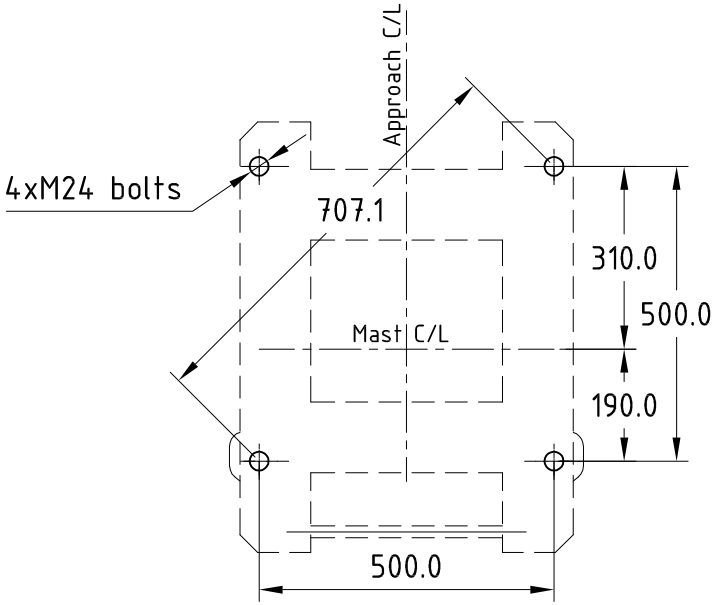
APPENDICES

Name of document	Number and revision
Mast list	
Foundation bolt lay out hinged base frame 400/500	641893B
Casting template for 400 mm & 500 mm mast	641794D
Foundation bolt lay out 500 mm fixed mast	641892B
Casting template for 500 mm fixed mast	641934A
Foundation bolt lay out 400 mm fixed mast	641011C
Casting template for 400 mm fixed mast	641830C
Approach light mast 500/400/5 assembly	641001A
Approach light mast 500/400/4 assembly	641002A
Approach light mast 500/400/3 assembly	641003A
Approach light mast 500/400/3 assembly	641188A
Approach light mast 500/400/2 assembly	641004A
Approach light mast 500/400/1 assembly	641005A
Approach light mast 400/5 assembly	641006A
Approach light mast 400/4 assembly	641007A
Approach light mast 400/3 assembly	641008A
Approach light mast 400/3 assembly	641187A
Approach light mast 400/2 assembly	641009A
Approach light mast 400/1 assembly	641010A
Centre hinged approach mast 5 lights	643166A
Centre hinged approach mast 4 lights	643167A
Centre hinged approach mast 3 lights	643168A
Centre hinged approach mast 3 lights	643169A
Centre hinged approach mast 2 lights	643170A
Centre hinged approach mast 1 light	643171A
Tilting devices	641975A
Adjustment tube clamp	641171
Strut arm pair	641199A
Installation of strut arm pair to a short mast	641907C
Top frame	641183
Cross bar clamp	641184
Adjustment of light height	642074

Item	Qty	Name	Shape, dim., drw. no.	Material	Weight
1	4	FOUNDATION BOLT HPM24/L - 24/P			
2	8	HEX NUT M24 KZN	DIN 934		
3	4	WASHER ø56/26x6 KZN			
4	1	CASTING TEMPLATE	641794C		

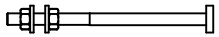
Positioning of the bolts



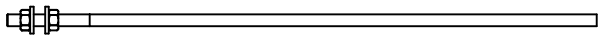


ALTERNATIVE FOUNDATION BOLTS

HPM24/L KZN, L=430 mm (16.9")



HPM24/P KZN, L=900 mm (35.4")



Rev.	Date	Information	Design.
B	2010-09-02	Protrution of bolts changed; pulttien ulkonema muuttunut	JMA

Project

Reference

Scale ~

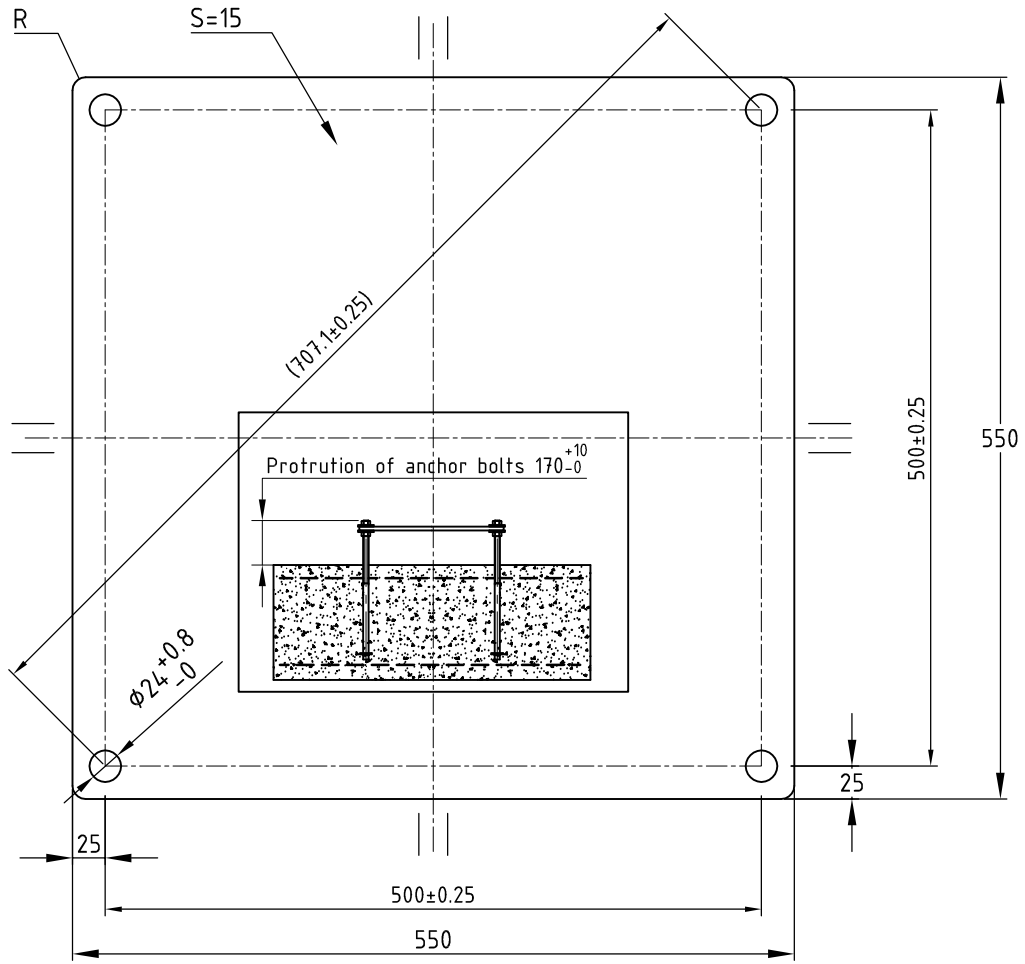
Title

FOUNDATION BOLT LAY-OUT
HINGED BASE; 4xM24 BOLTS

EXEL COMPOSITES
KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

Drw. no. 641893B

Item	Qty	Name	Shape, dim., drw. no.	Material	Remark



Approach C/L

Sharp edges rounded

D	16-08-17	Material changed to film-faced plywood	JsK
Rev.	Date	Information	Design.

		Film-faced Plywood 15	Filmivaneri 15	590*590		
Nro	Drawing nr	Name	Standard	Form	Material	Pcs

Project

Reference

Scale 1:4

Title

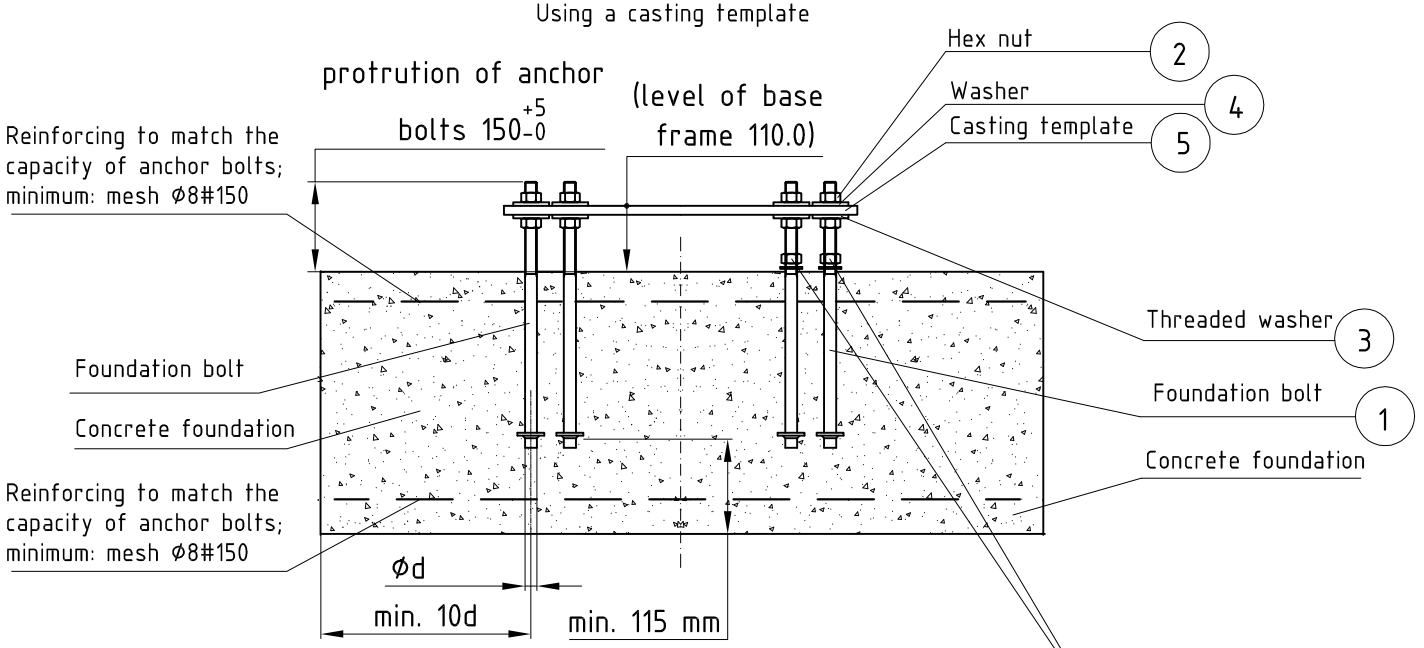
Casting template L400 & L500 mast/tower M24 anchor bolts

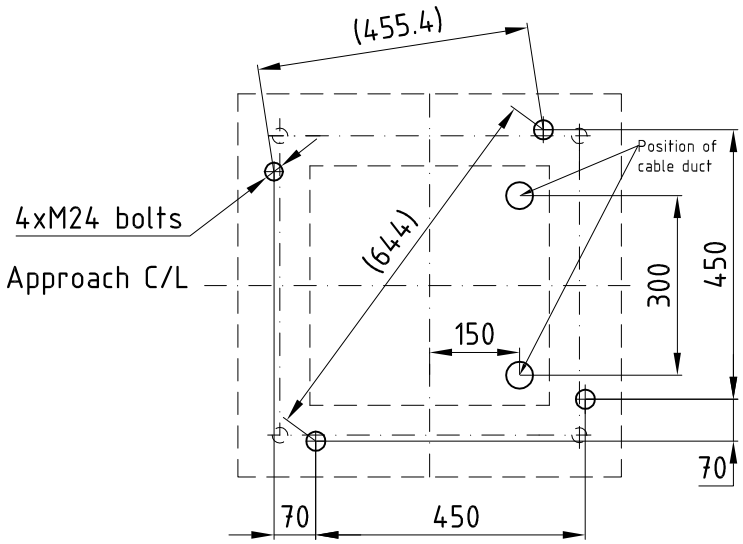
KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

Drw. no. 641794D

Positioning of the anchor bolts

Using a casting template





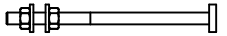
One additional hex nut M24 and washer ⌀56/26x6 on both foundation bolts to hold the hinge tool in place on the tilting side of the mast.

Tilting direction of the mast

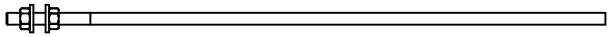
Item	Qty	Name	Shape, dim., drw. no.	Material	Weight
1	4	FOUNDATION BOLT HPM24/L - 24/P			
2	8+2	HEX NUT M24 KZN	DIN 934		
3	4	WASHER ⌀60/M24x10 MM	641881	AISI 304	
4	4	WASHER ⌀60/⌀24x8 MM	641880	AISI 304	
5	1	CASTING TEMPLATE	641934 - USED ONLY WHEN CASTING THE FOUNDATION		

ALTERNATIVE FOUNDATION BOLTS

HPM24/L KZN, L=430 mm (16.9")



HPM24/P KZN, L=900 mm (35.4")



Rev.	Date	Information	Design.
B	2011-04-06	Template and reinforcing updated; valumalline ja raudoitus muutettu	JMA

Project

Reference

Scale ~

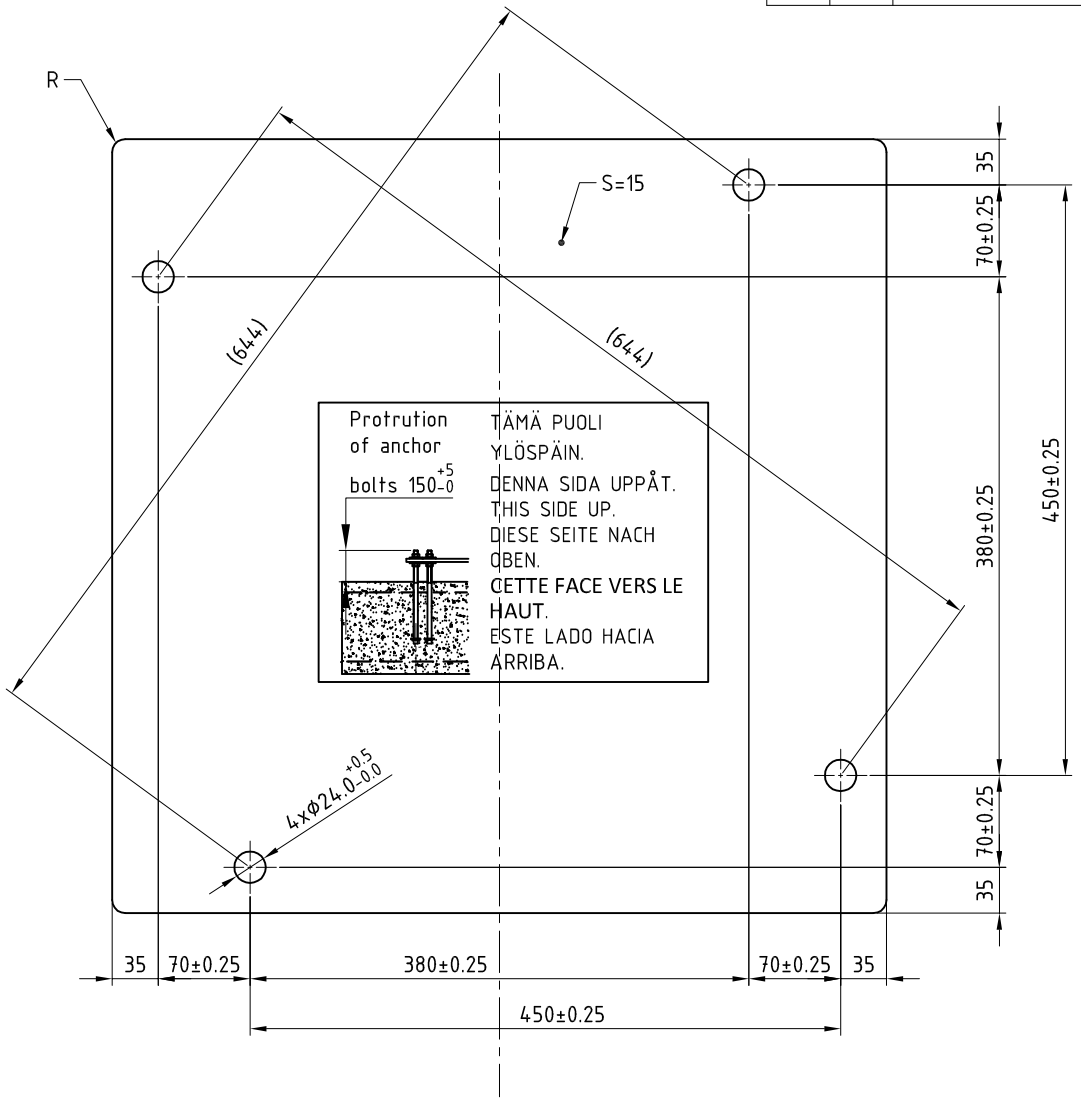
Title

FOUNDATION BOLT LAY-OUT
L500 MAST; 4xM24 BOLTS

exel composites
KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

Drw. no. 641892B

Item	Qty	Name	Shape, dim., drw. no.	Material	Remark



Approach C/L

Sharp edges rounded

		Film-faced plywood 15	Filmivaneri 15	590*590		
Nro	Drawing nr	Name	Standard	Form	Material	Pcs

Project

Reference

Scale 1:4

Title

Casting template L500 mast/tower M24 bolts

KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

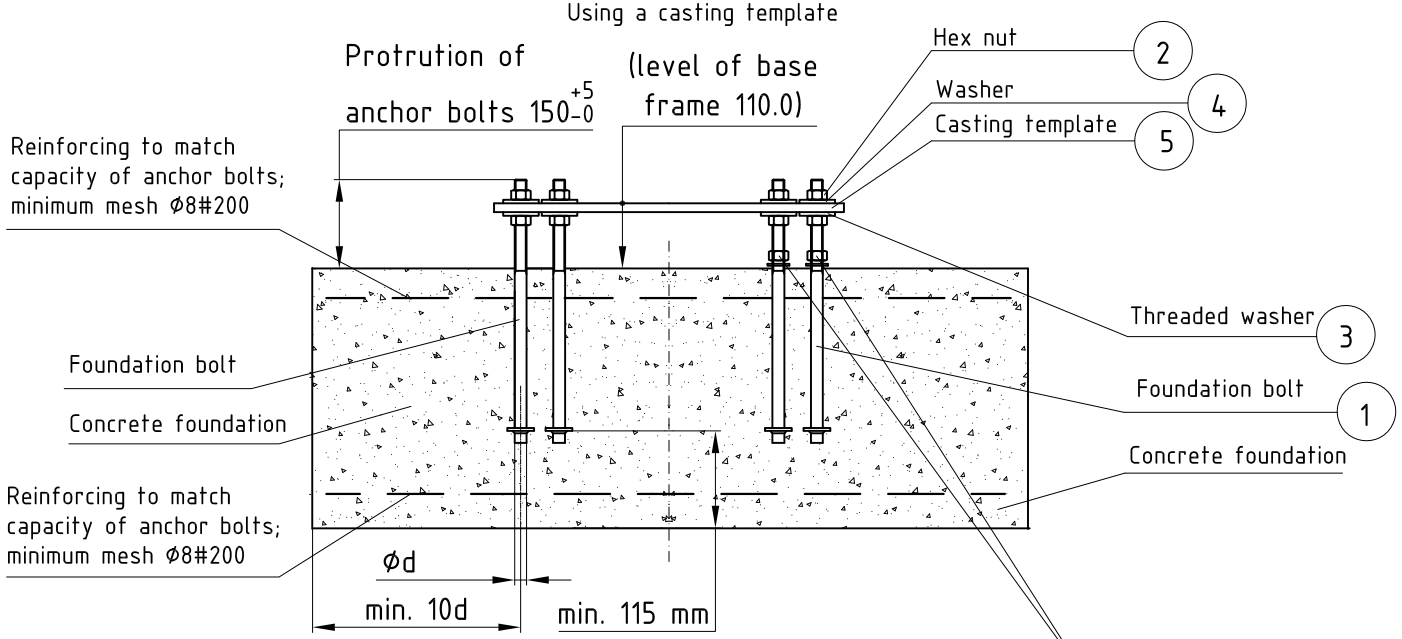
Drw. no. 641934A

Rev.	Date	Information	Design.
	22.08.2016	Material updated to film-faced plywood	JsK

Positioning of the anchor bolts

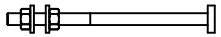
Item	Qty	Name	Shape, dim., drw. no.	Material	Weight
1	4	FOUNDATION BOLT HPM20/L - 20/P			
2	8+2	HEX NUT M20 KZN	DIN 934		
3	4	WASHER Ø60/M20x10 MM	641683	AISI 304	
4	4	WASHER Ø60/Ø20x8 MM	641684	AISI 304	
5	1	CASTING TEMPLATE	641830B - USED ONLY WHEN CASTING THE FOUNDATION		

Using a casting template

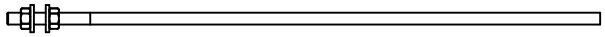


ALTERNATIVE FOUNDATION BOLTS

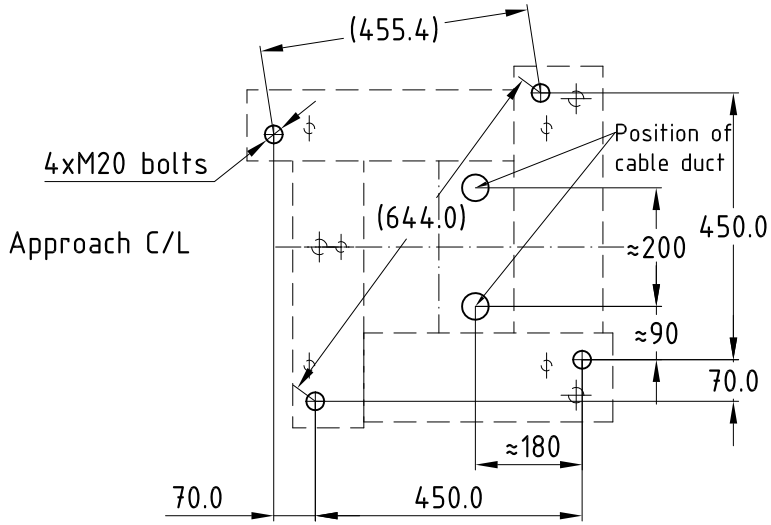
HPM20/L KZN, L=350 mm (13.8")



HPM20/P KZN, L=1100 mm (43.3")



One additional hex nut M20 and washer Ø37/22x3 on both foundation bolts to hold the hinge tool in place on the tilting side of the mast.



Tilting direction of the mast

Rev.	Date	Information	Design.
C	2015-02-10	Outline of base frame changed; pohjakehän ääriviivat muutettu	JMA

Project

Reference

Scale ~

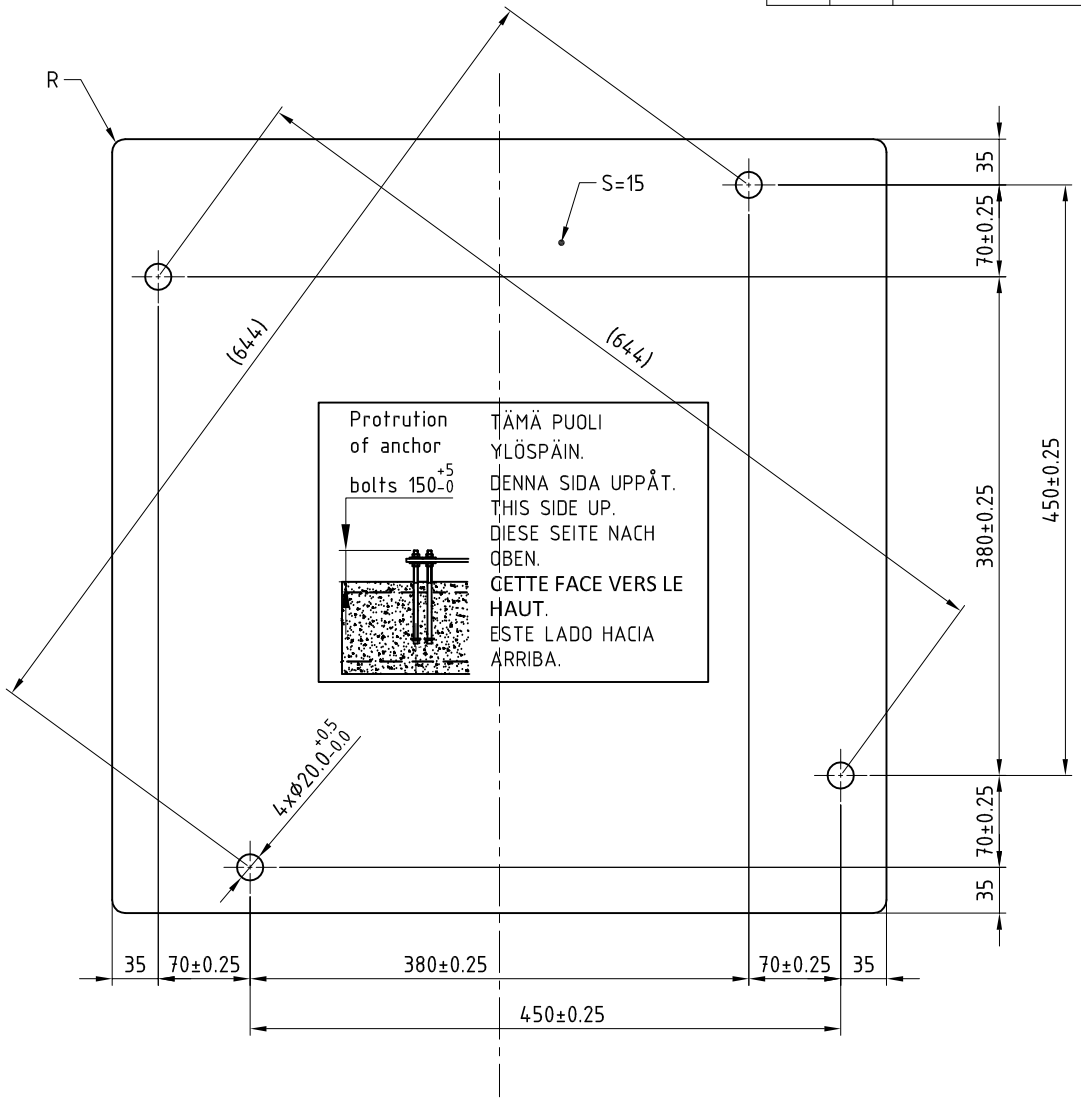
Title

FOUNDATION BOLT LAY-OUT
L400, T400 & T500 MASTS
4xM20 BOLTS

EXEL COMPOSITES
KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINAVAARA

Drw. no. 641011C

Item	Qty	Name	Shape, dim., drw. no.	Material	Remark



Approach C/L

Sharp edges rounded

Nro	Drawing nr	Name	Standard	Form	Material	Pcs
		Film-faced plywood 15 /	Filmivaneri 15	590*590		

Project

Reference

Scale 1:4

Title

Casting template L400 mast/tower M20 bolts

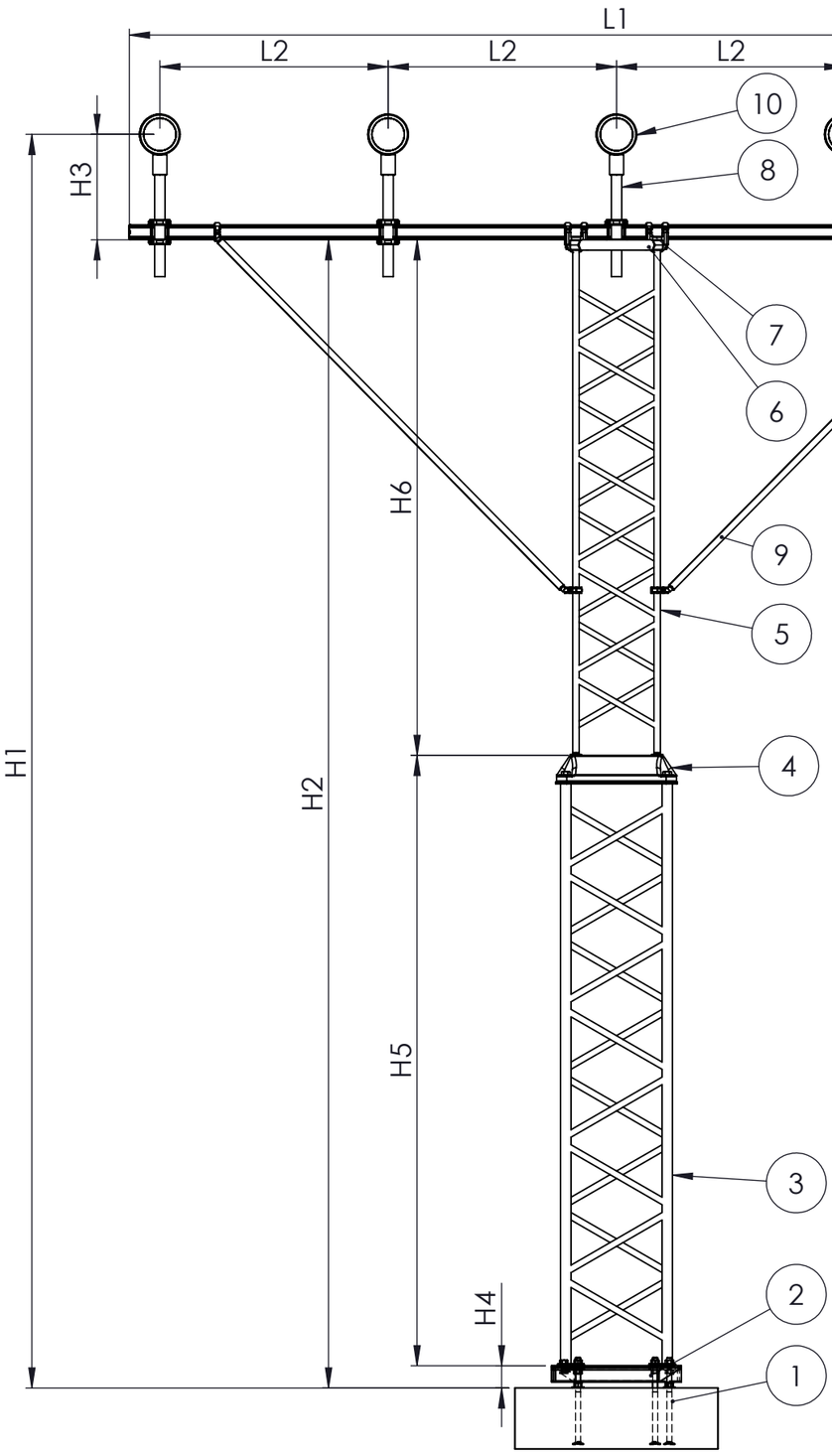
exel COMPOSITES

KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

Drw. no. 641830C

Rev.	Date	Information	Design.
C	22.08.2016	Material updated to film-faced plywood	JsK

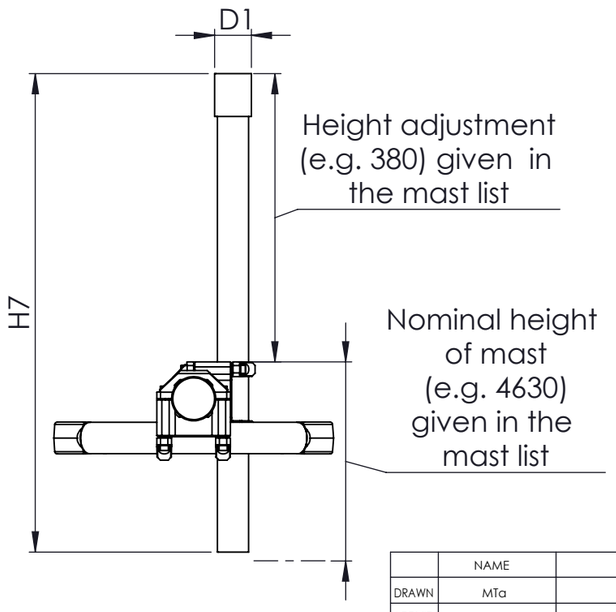
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L500 Base frame
3	MAST MODULE 500
4	Joint piece
5	MAST MODULE 400
6	Top Frame L400
7	Cross-bar tube
8	Light mounting
9	Strut arm assembly
10	Light (not included in delivery)
11	Wiring cover tubes (optional)



H1 = Light height from base level
H2 = Height of mast modules
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of L500 mast module
H6 = Height of L400 mast module
H7 = Height of adjustment tube

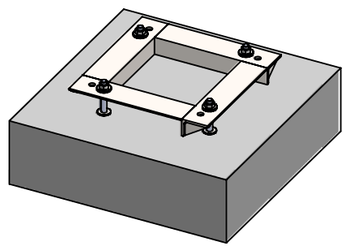
L1 = Cross-bar tube lenght
L2 = Light spacing

D1 = Diameter of light bracket

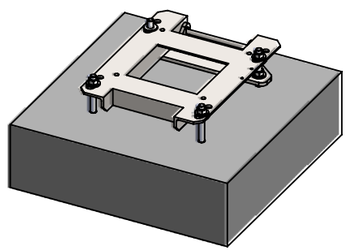


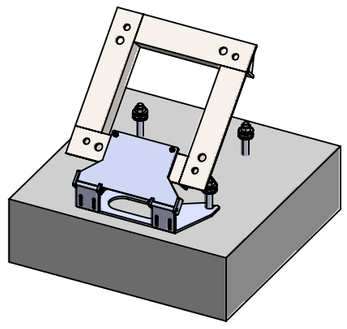
Base frames

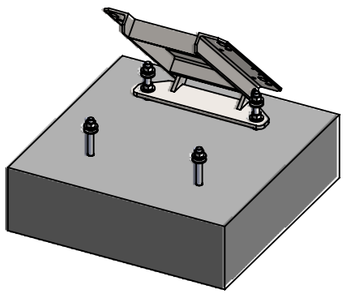
L500 Fixed base frame
L500 with hingetool



L500 Hinged base frame







	NAME		DATE
DRAWN	MTa		4.3.2019
APPV'D			

TITLE: Approach lattice mast, 5 lights

PROJECT

DWG NO. 641001A

A3

WEIGHT kg:

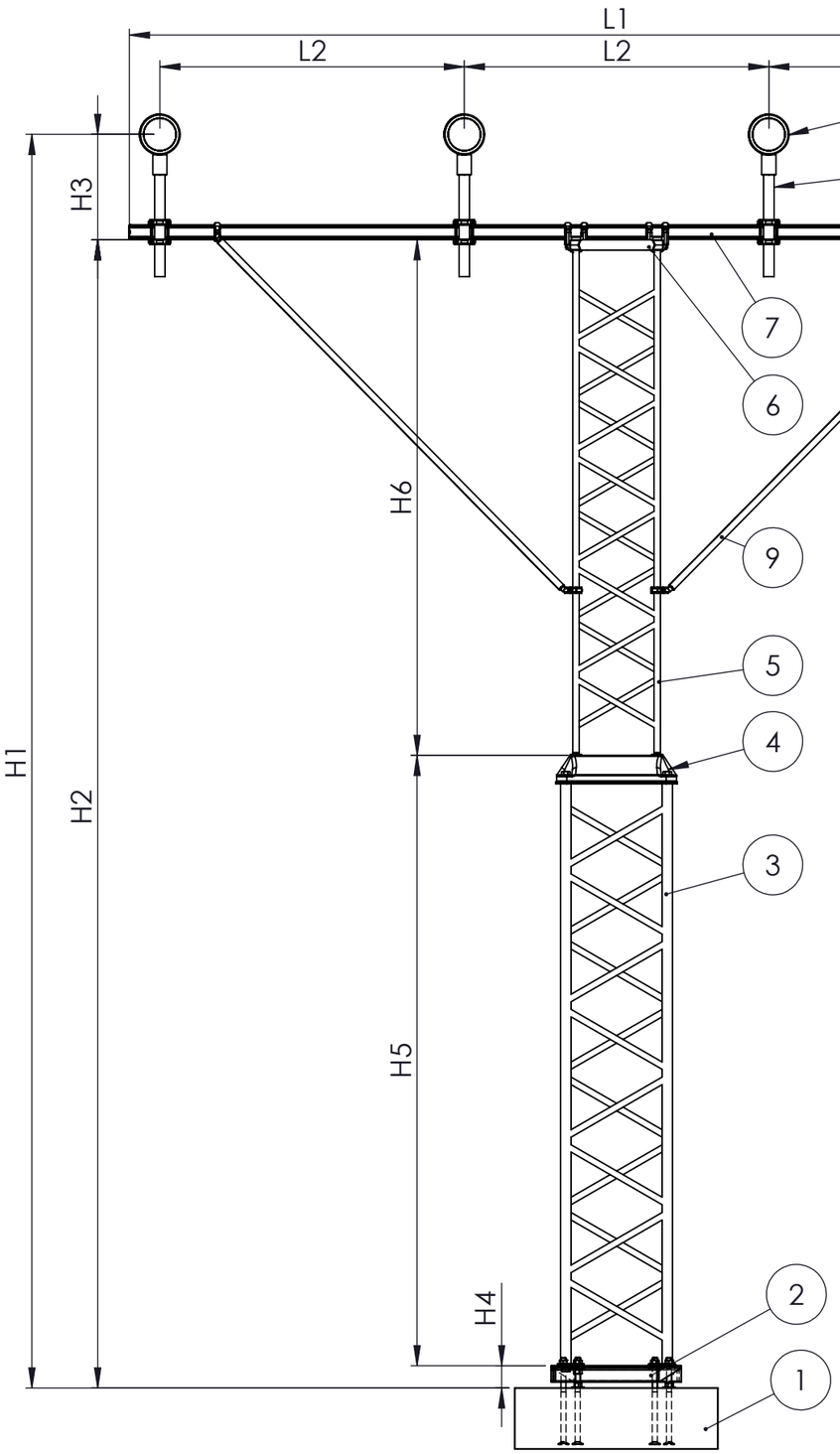
SCALE:1:30

SHEET 1 OF 1

4. maaliskuuta 2019 11:56:56

G:\KVA\Asiakirjat\Tuoteryhmat\Mastot\Dwg\641001A

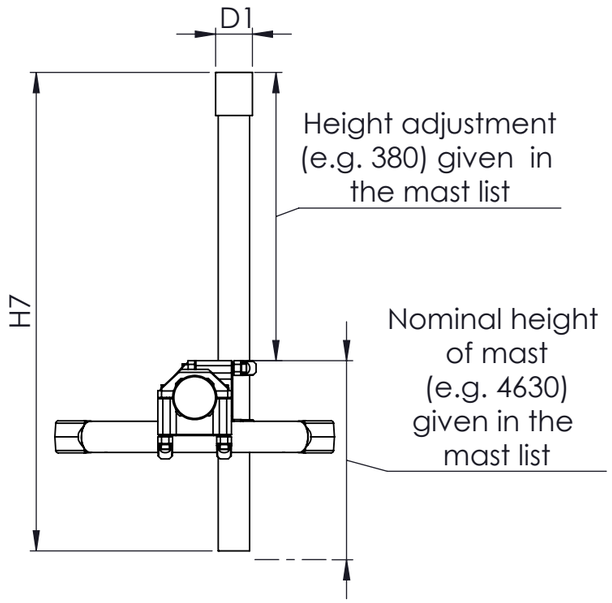
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L500 Base Frame
3	MAST MODULE 500
4	Joint piece
5	MAST MODULE 400
6	Top Frame L400
7	Cross-bar tube
8	Light mounting
9	Strut arm assembly
10	Light (not included in delivery=
11	Wiring cover tubes (optional)



H1 = Light height from base level
H2 = Height of mast modules
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of L500 mast module
H6 = Height of L400 mast module
H7 = Height of adjustment tube

L1 = Cross-bar tube lenght
L2 = Light spacing

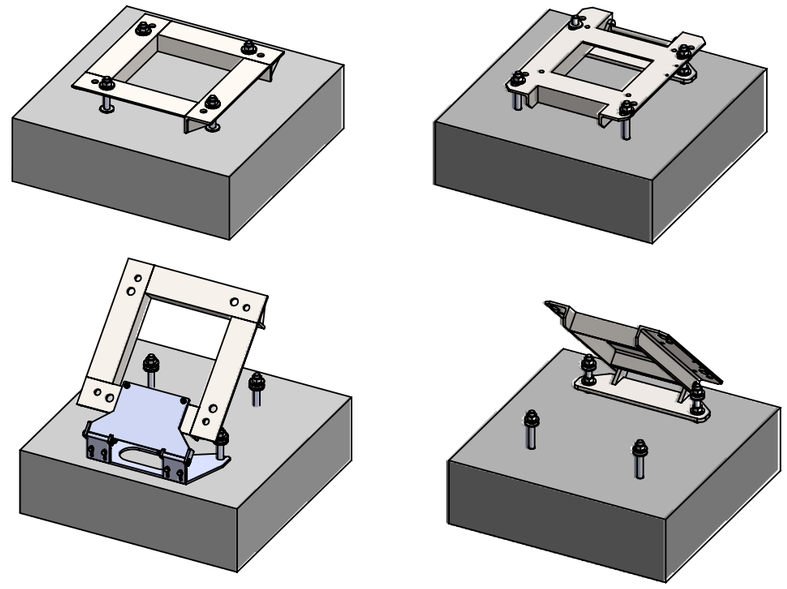
D1 = Diameter of light bracket



Base frames

L500 Fixed base frame
L500 with hingetool

L500 Hinged base frame



	NAME		DATE
DRAWN	MTa		4.3.2019
APPV'D			

TITLE: Approach lattice mast, 4 lights

PROJECT

DWG NO. 641002A

A3

WEIGHT kg:

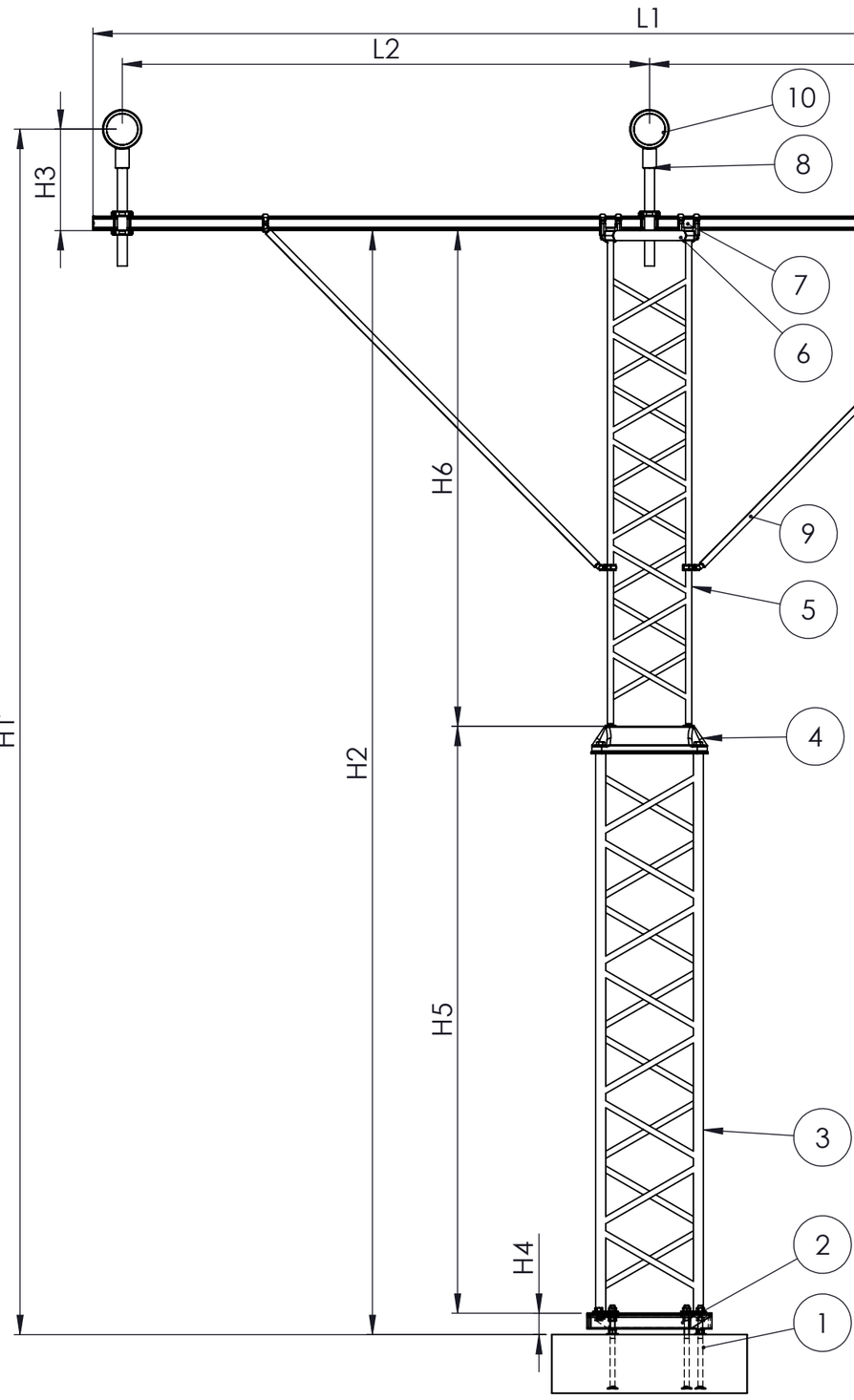
SCALE:1:30

SHEET 1 OF 1

4. maaliskuuta 2019 12:08:30

G:\KVA\Asiakirjat\Tuoteryhmat\Mastot\Dwg\641002A

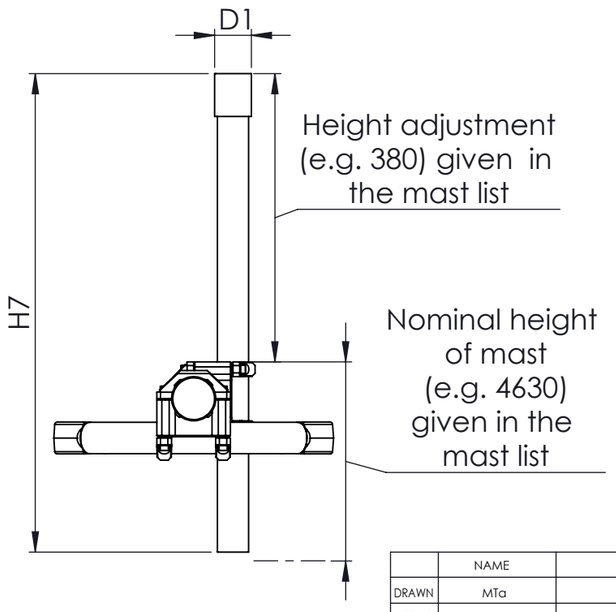
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L500 Base frame
3	MAST MODULE 500
4	Joint piece
5	MAST MODULE 400
6	Top Frame L400
7	Cross-bar tube
8	Light mounting
9	Strut arm assembly
10	Light (not included in delivery)
11	Wiring cover tubes (optional)



H1 = Light height from base level
H2 = Height of mast modules
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of L500 mast module
H6 = Height of L400 mast module
H7 = Height of adjustment tube

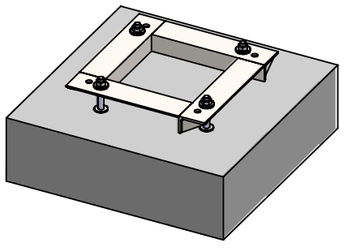
L1 = Cross-bar tube lenght
L2 = Light spacing

D1 = Diameter of light bracket

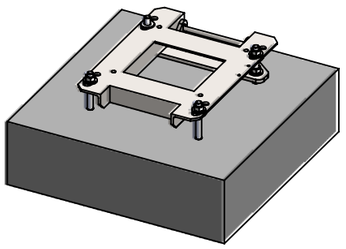


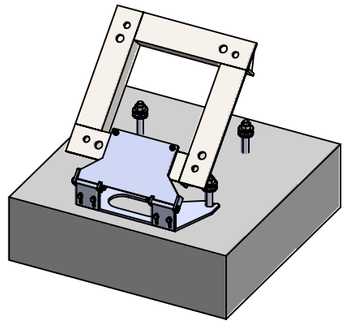
Base frames

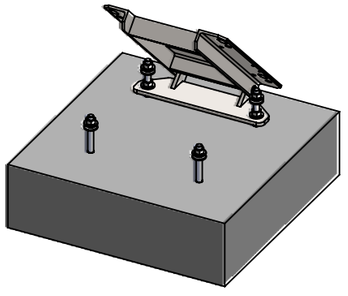
L500 Fixed base frame
L500 with hingetool



L500 Hinged base frame







	NAME		DATE
DRAWN	MTa		4.3.2019
APPV'D			

TITLE: Approach lattice mast, 3 lights

PROJECT

DWG NO. 641003A

A3

WEIGHT kg:

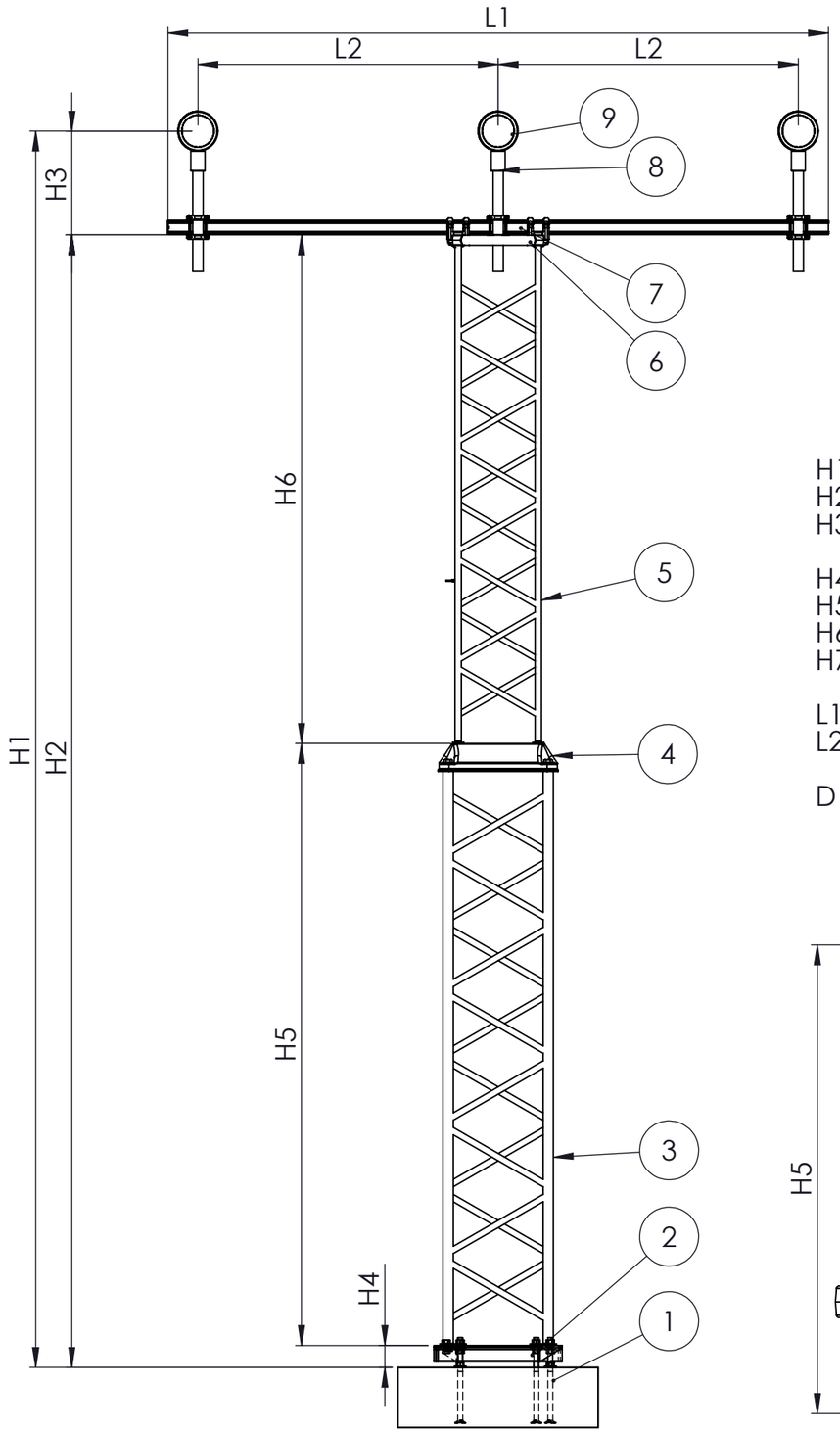
SCALE:1:30

SHEET 1 OF 1

4. maaliskuuta 2019 12:12:06

G:\KVA\Asiakirjat\Tuoteryhmat\Mastot\Dwg\641003A

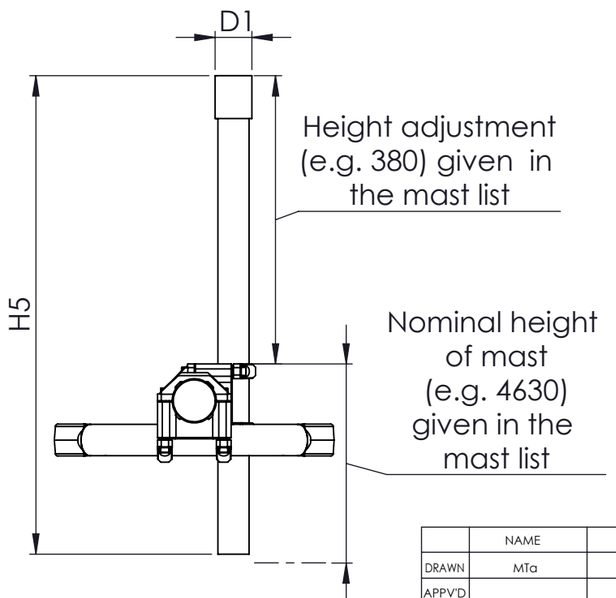
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L500 Base frame
3	MAST MODULE 500
4	Joint piece
5	MAST MODULE 400
6	Top Frame L400
7	Cross-bar tube
8	Light mounting
9	Light (not included in delivery)
10	Wiring cover tubes (optional)



H1 = Light height from base level
H2 = Height of mast modules
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of L500 mast module
H6 = Height of L400 mast module
H7 = Height of adjustment tube

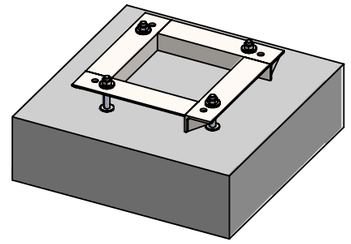
L1 = Cross-bar tube lenght
L2 = Light spacing

D1 = Diameter of light bracket

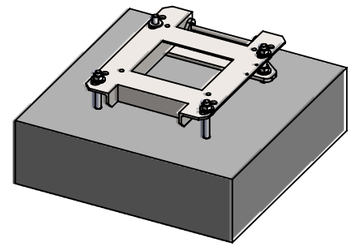


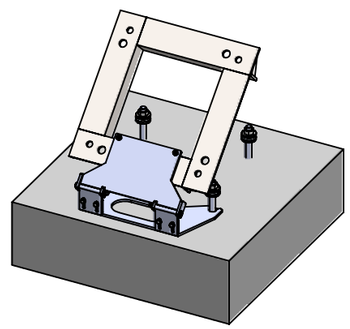
Base frames

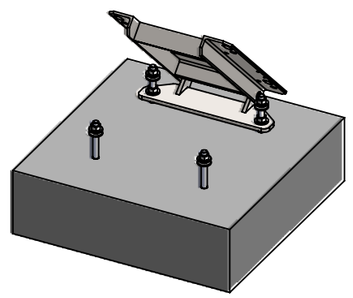
L500 Fixed base frame
L500 with hingetool



L500 Hinged base frame







	NAME		DATE
DRAWN	MTa		4.3.2019
APPV'D			

TITLE: Approach lattice mast, 3 lights

PROJECT

DWG NO. 641188A

A3

WEIGHT kg:

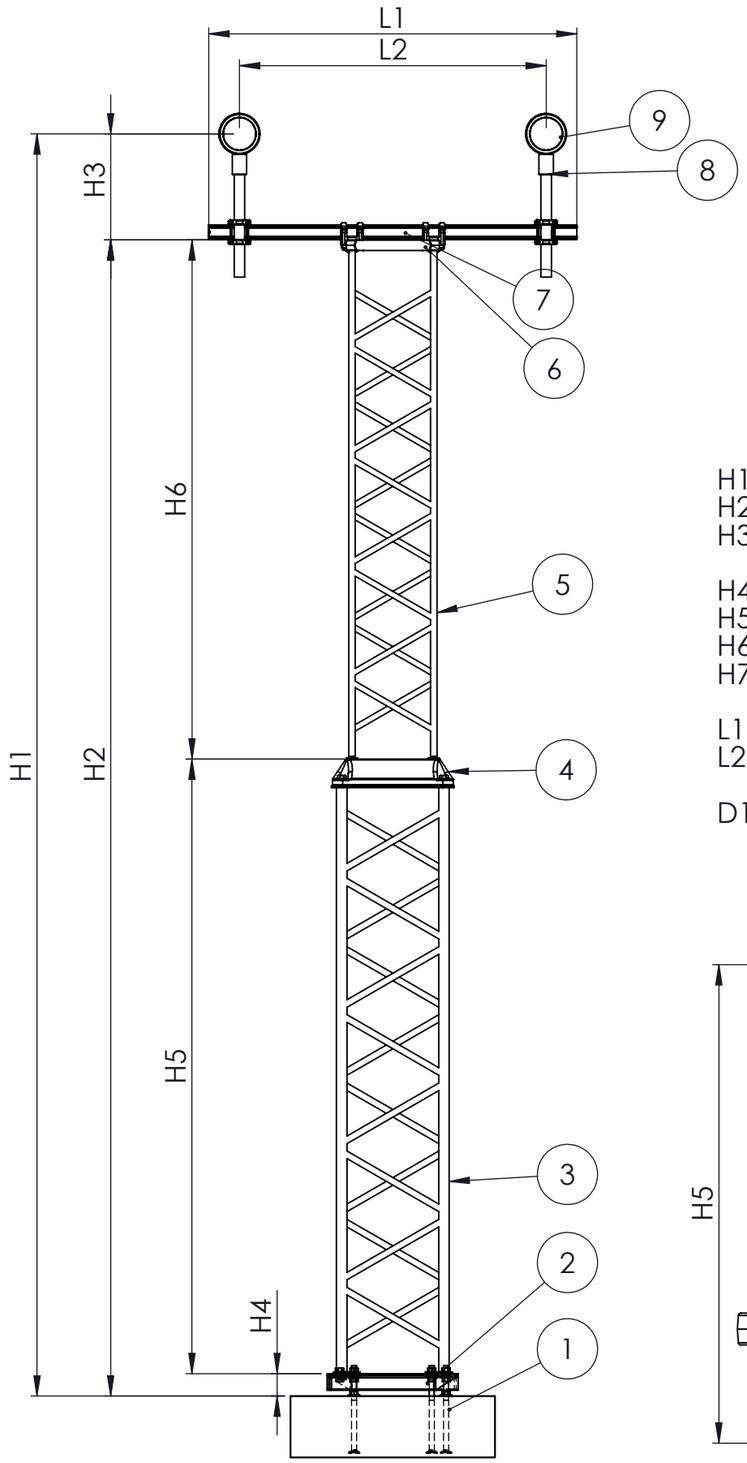
SCALE:1:30

SHEET 1 OF 1

4. maaliskuuta 2019 12:13:56

G:\KVA\Asiakirjat\Tuoteryhmat\Mastot\Dwg\641188A

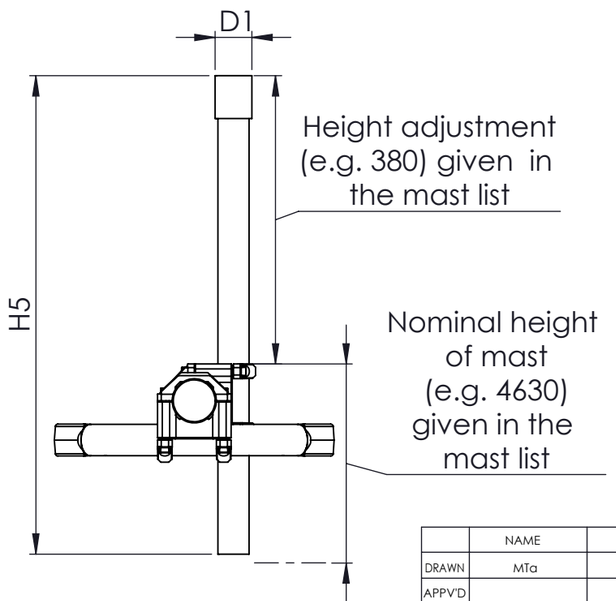
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L500 Base frame
3	MAST MODULE 500
4	Joint piece
5	MAST MODULE 400
6	Top Frame L400
7	Cross-bar tube
8	Light mounting
9	Light (not included in delivery)
10	Wiring cover tubes (optional)



H1 = Light height from base level
H2 = Height of mast modules
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of L500 mast module
H6 = Height of L400 mast module
H7 = Height of adjustment tube

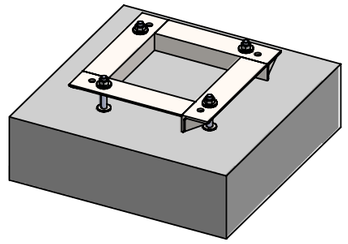
L1 = Cross-bar tube lenght
L2 = Light spacing

D1 = Diameter of light bracket

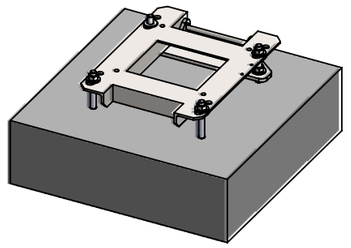


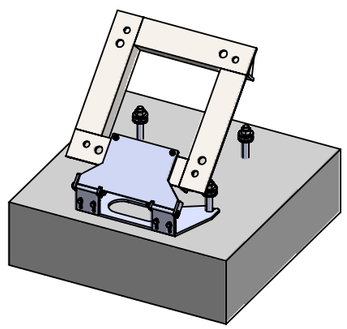
Base frames

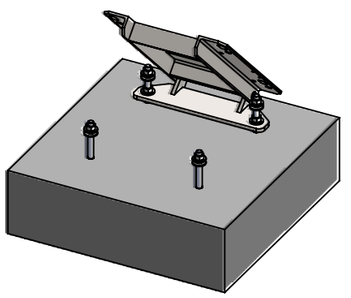
L500 Fixed base frame
L500 with hingetool



L500 Hinged base frame







	NAME		DATE
DRAWN	MTa		4.3.2019
APPV'D			

TITLE: Approach lattice mast, 2 lights

PROJECT

DWG NO. 641004A

A3

WEIGHT kg:

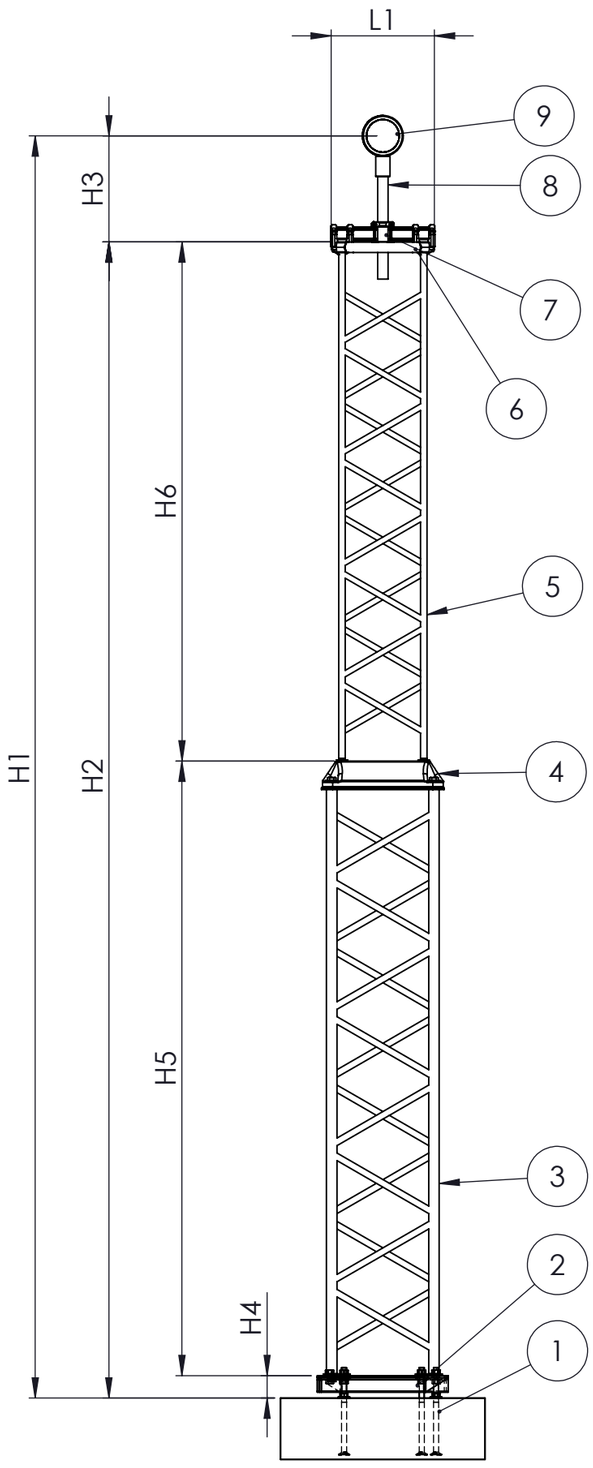
SCALE:1:30

SHEET 1 OF 1

4. maaliskuuta 2019 12:15:48

G:\KVA\Asiakirjat\Tuoteryhmat\Mastot\Dwg\641004A

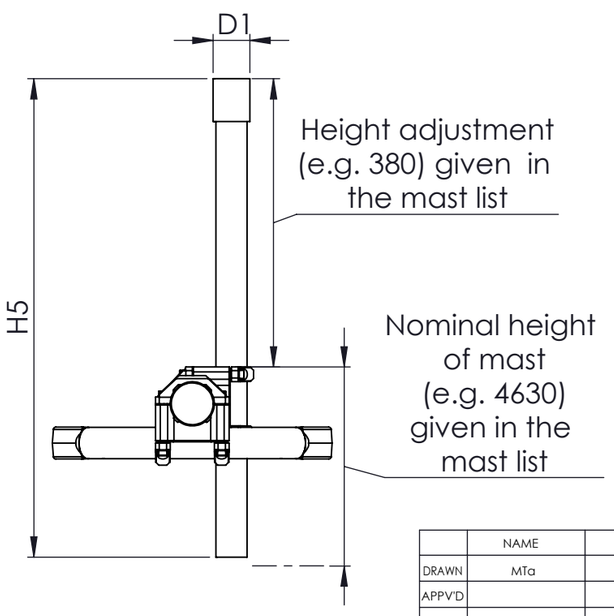
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L500 Base frame
3	MAST MODULE 500
4	Joint piece
5	MAST MODULE 400
6	Top Frame L400
7	Cross-bar tube
8	Light mounting
9	Light (not included in delivery)
10	Wiring cover tubes (optional)



H1 = Light height from base level
H2 = Height of mast modules
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of L500 mast module
H6 = Height of L400 mast module
H7 = Height of adjustment tube

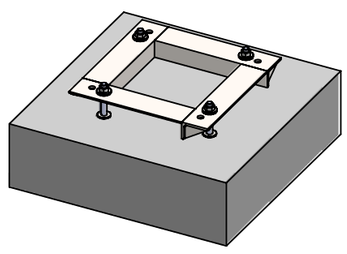
L1 = Cross-bar tube lenght

D1 = Diameter of light bracket

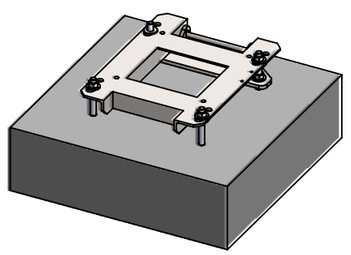


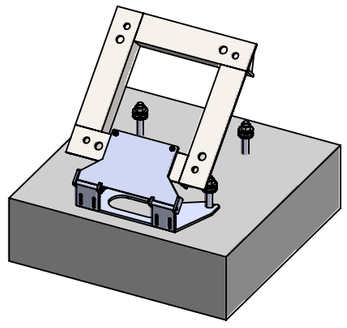
Base frames

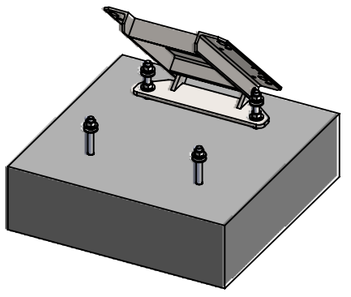
L500 Fixed base frame
L500 with hingetool



L500 Hinged base frame







	NAME		DATE
DRAWN	MTa		4.3.2019
APPV'D			

TITLE: Approach lattice mast, 1 light

PROJECT

DWG NO. 641005A

A3

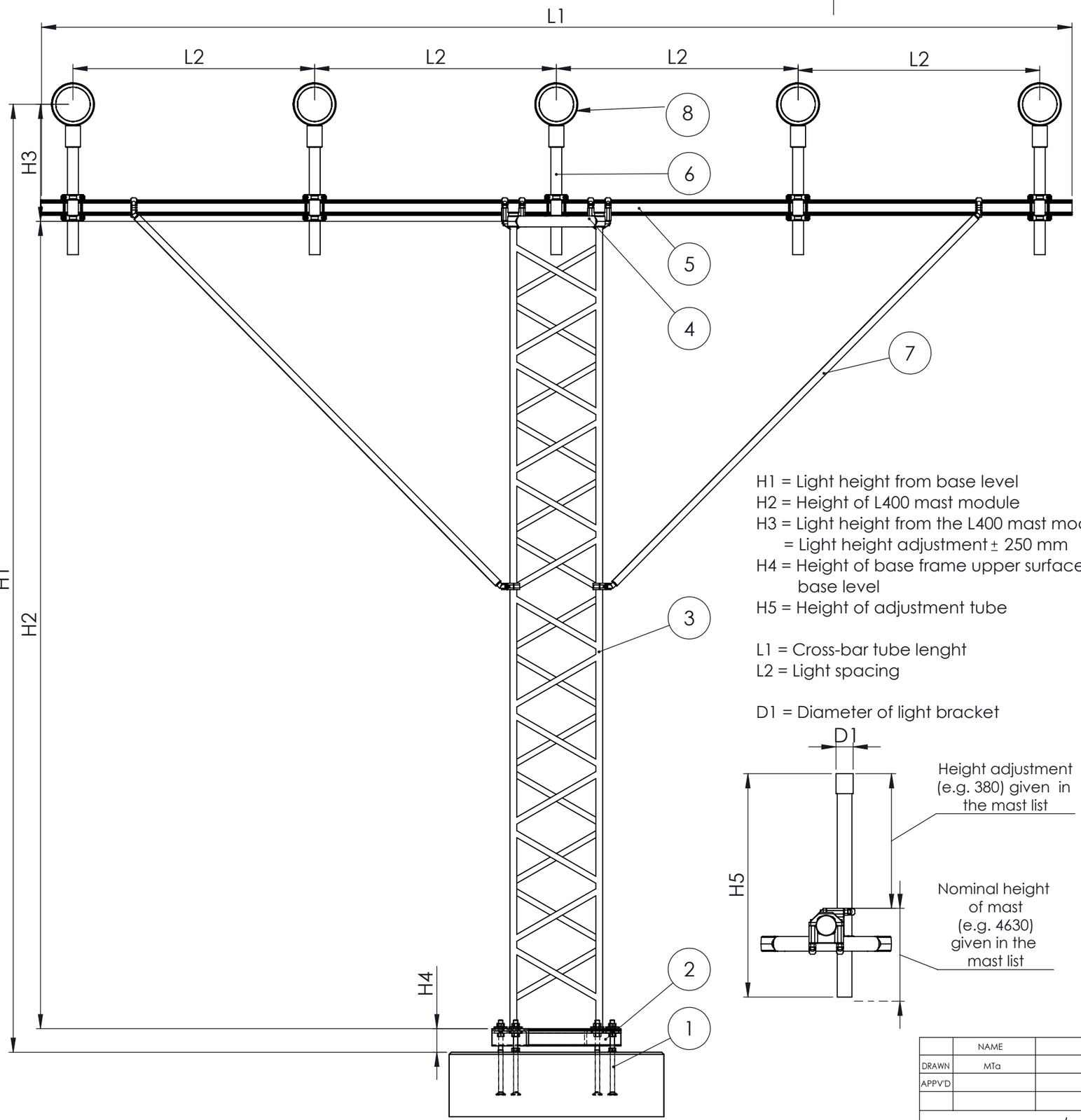
WEIGHT kg:

SCALE:1:30

SHEET 1 OF 1

4. maaliskuuta 2019 11:55:30

G:\KVA\Asiakirjat\Tuoteryhmat\Mastot\Dwg\641005A



ITEM NO.	DESCRIPTION
1	Foundation parts
2	L400 base Frame
3	Mast Module L400
4	Top Frame L400
5	Cross-bar tube
6	Light mounting
7	Strut arm assembly
8	Light (Not included in delivery)
9	Wiring cover tubes (optional)

H1 = Light height from base level
H2 = Height of L400 mast module
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of adjustment tube

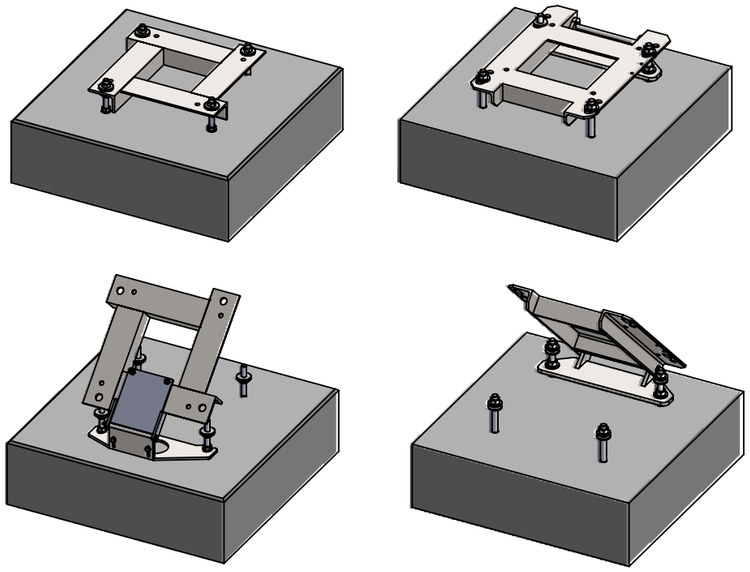
L1 = Cross-bar tube lenght
L2 = Light spacing

D1 = Diameter of light bracket

Base frames

L400 Fixed base frame
L400 with hingetool

L400 Hinged base frame



	NAME		DATE
DRAWN	MTa		4.3.2019
APPV'D			

TITLE: Approach lattice mast L400, 5 lights

PROJECT

DWG NO. 641006-A

A3

WEIGHT kg:

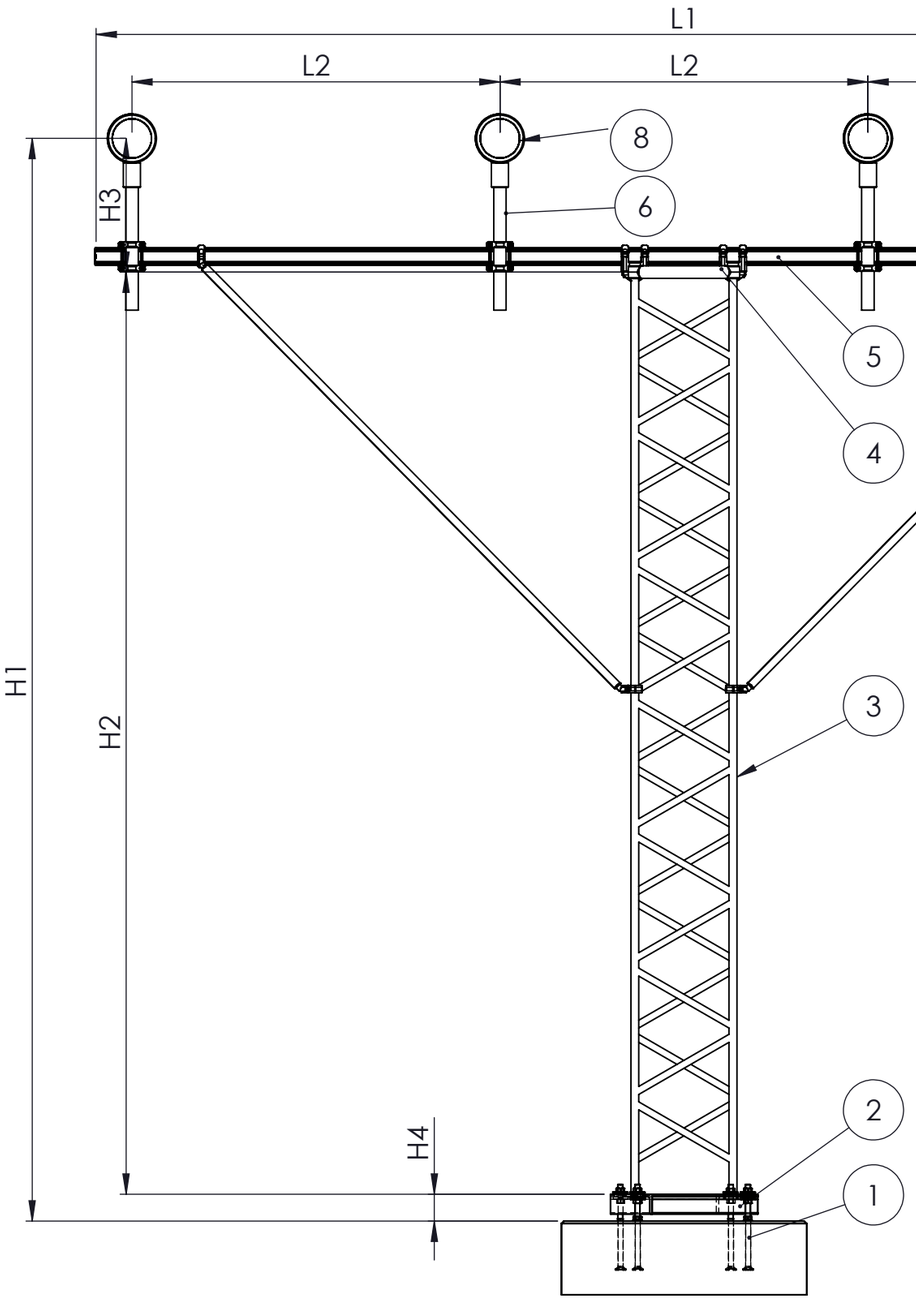
SCALE:1:20

SHEET 1 OF 1

4. maaliskuuta 2019 12:39:17

G:\KVA\Asiakirjat\Tuoteryhmat\Mastot\Dwg\641006-A

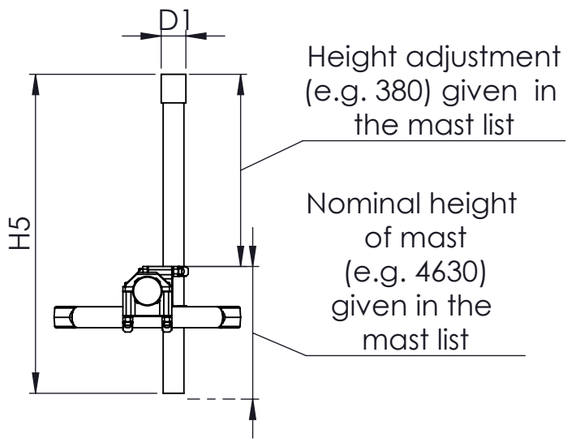
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L400 base Frame
3	Mast Module L400
4	Top Frame L400
5	Cross-bar tube
6	Light mounting
7	Strut arm assembly
8	Light (Not included in delivery)
9	Wiring cover tubes (optional)



H1 = Light height from base level
H2 = Height of L400 mast module
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of adjustment tube

L1 = Cross-bar tube lenght
L2 = Light spacing

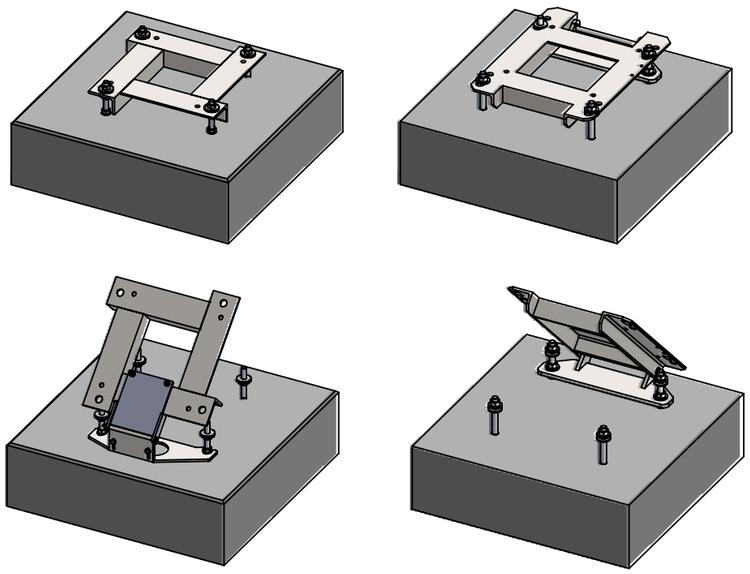
D1 = Diameter of light bracket



Base frames

L400 Fixed base frame
L400 with hingetool

L400 Hinged base frame



	NAME		DATE
DRAWN	MTa		4.3.2019
APPV'D			

TITLE: Approach Lattice mast L400, 4 lights

PROJECT

DWG NO. 641007-A

A3

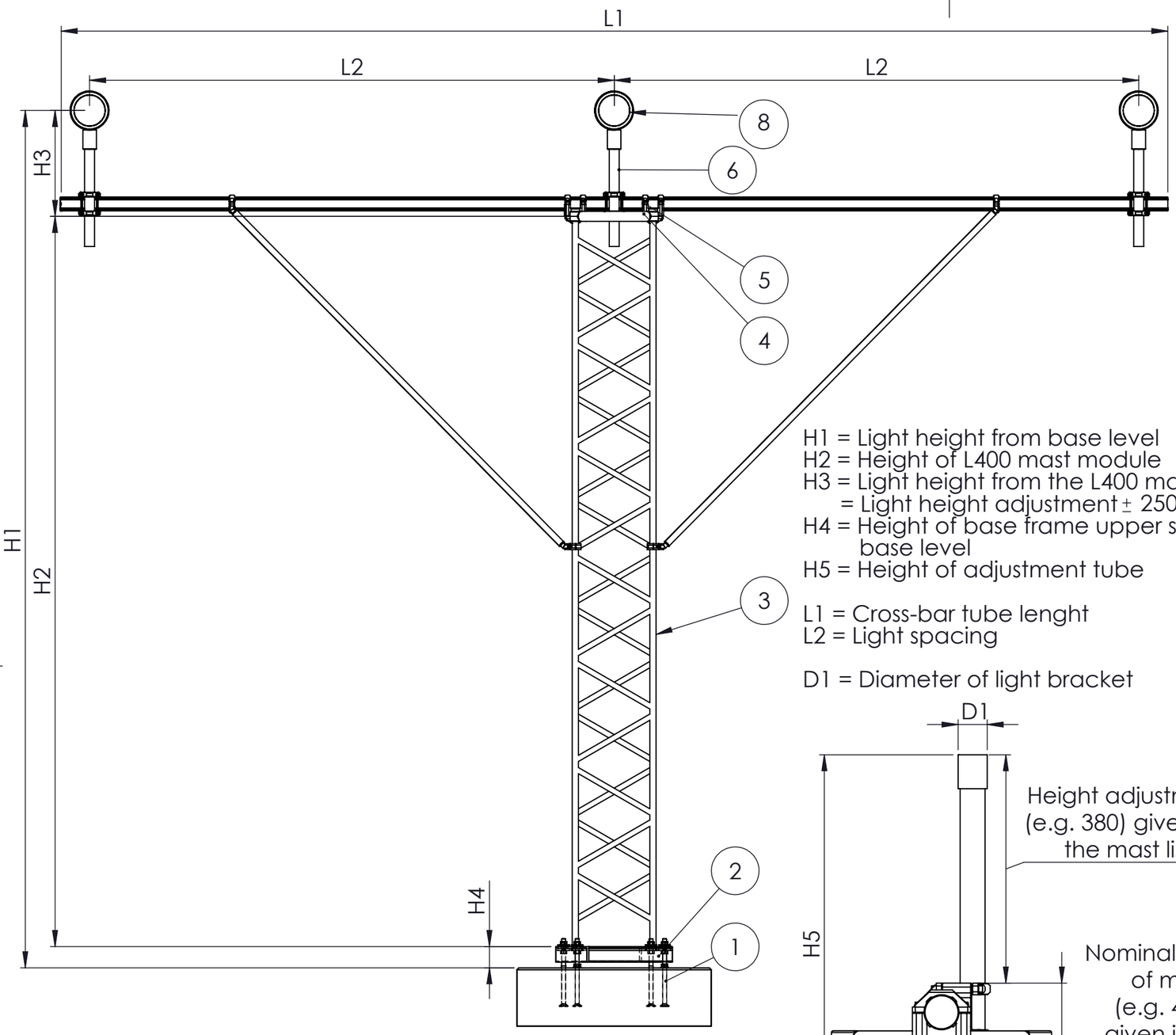
WEIGHT kg:

SCALE:1:20

SHEET 1 OF 1

4. maaliskuuta 2019 12:38:49

G:\KVA\Asiakirjat\Tuoteryhmat\Mastot\Dwg\641007-A

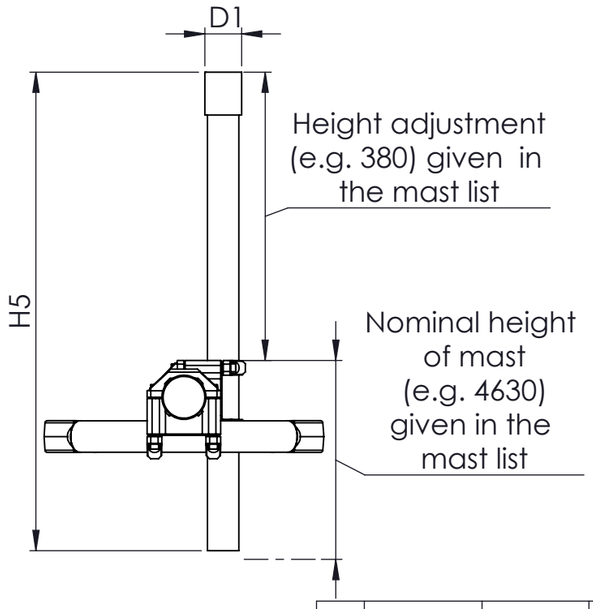


ITEM NO.	DESCRIPTION
1	Foundation parts
2	L400 base Frame
3	Mast Module L400
4	Top Frame L400
5	Cross-bar tube
6	Light mounting
7	Strut arm assembly
8	Light (Not included in delivery)
9	Wiring cover tubes (optional)

H1 = Light height from base level
H2 = Height of L400 mast module
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of adjustment tube

L1 = Cross-bar tube lenght
L2 = Light spacing

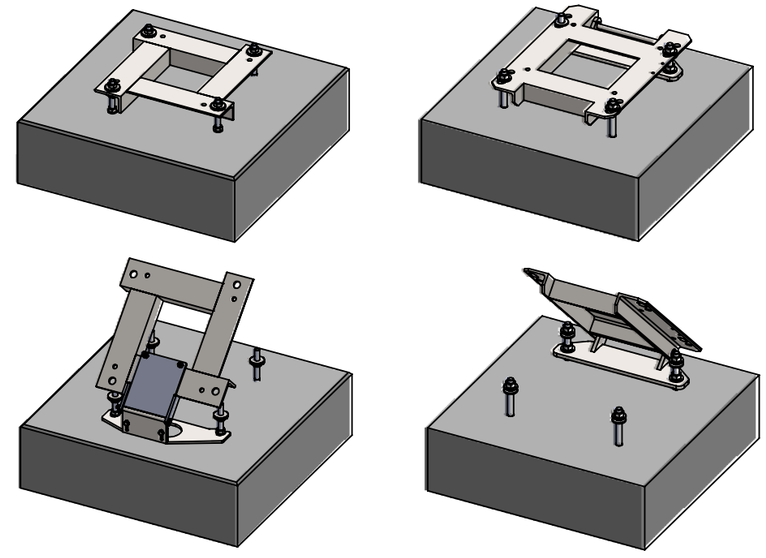
D1 = Diameter of light bracket



Base frames

L400 Fixed base frame
L400 with hingetool

L400 Hinged base frame



	NAME		DATE
DRAWN	MTa		4.3.2019
APPV'D			

TITLE: Approach lattice mast L400, 3 lights

PROJECT

DWG NO. 641008-A

A3

WEIGHT kg:

SCALE:1:20

SHEET 1 OF 1

4. maaliskuuta 2019 13:01:15

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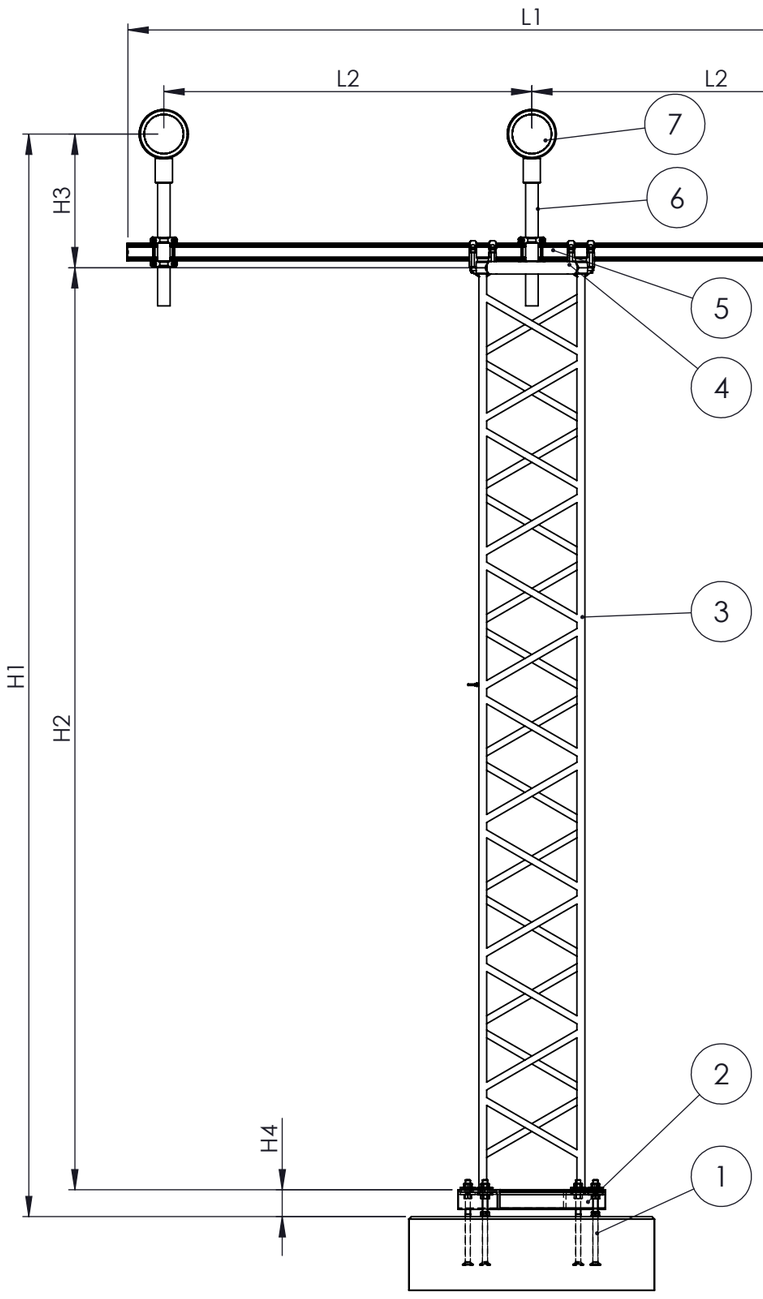
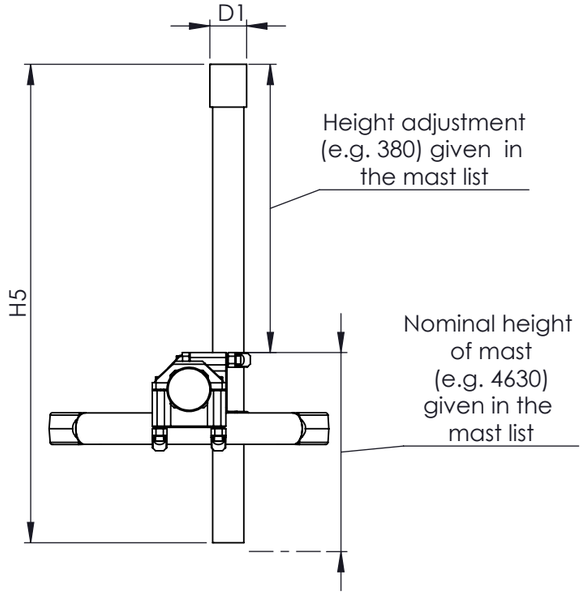
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L400 base Frame
3	Mast Module L400
4	Top Frame L400
5	Cross-bar tube
6	Light mounting
7	Light (Not included in delivery)
8	Wiring cover tubes (optional)
23	Hex. Socket Screw



H1 = Light height from base level
H2 = Height of L400 mast module
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of adjustment tube

L1 = Cross-bar tube lenght
L2 = Light spacing

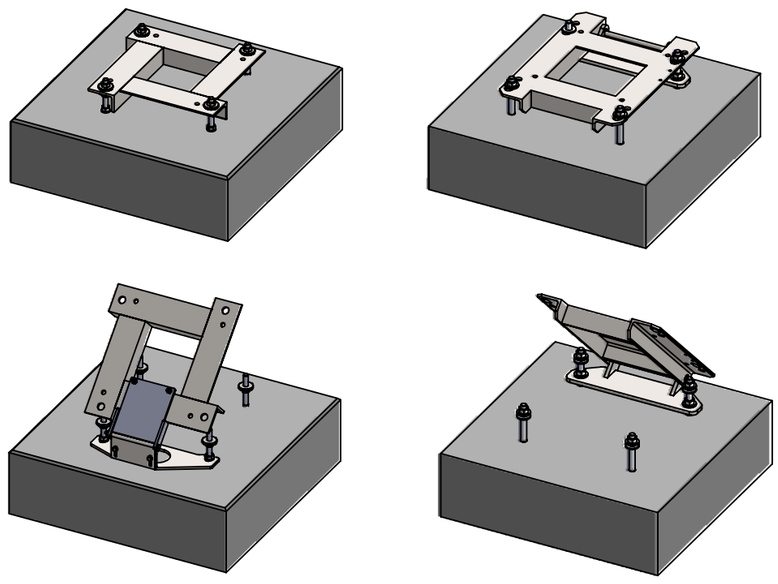
D1 = Diameter of light bracket



Base frames

L400 Fixed base frame
L400 with hingetool

L400 Hinged base frame



	NAME		DATE
DRAWN	MTa		4.3.2019
APPV'D			

TITLE: Approach lattice mast L400, 3 lights

PROJECT

DWG NO. 641187-A

A3

WEIGHT kg:

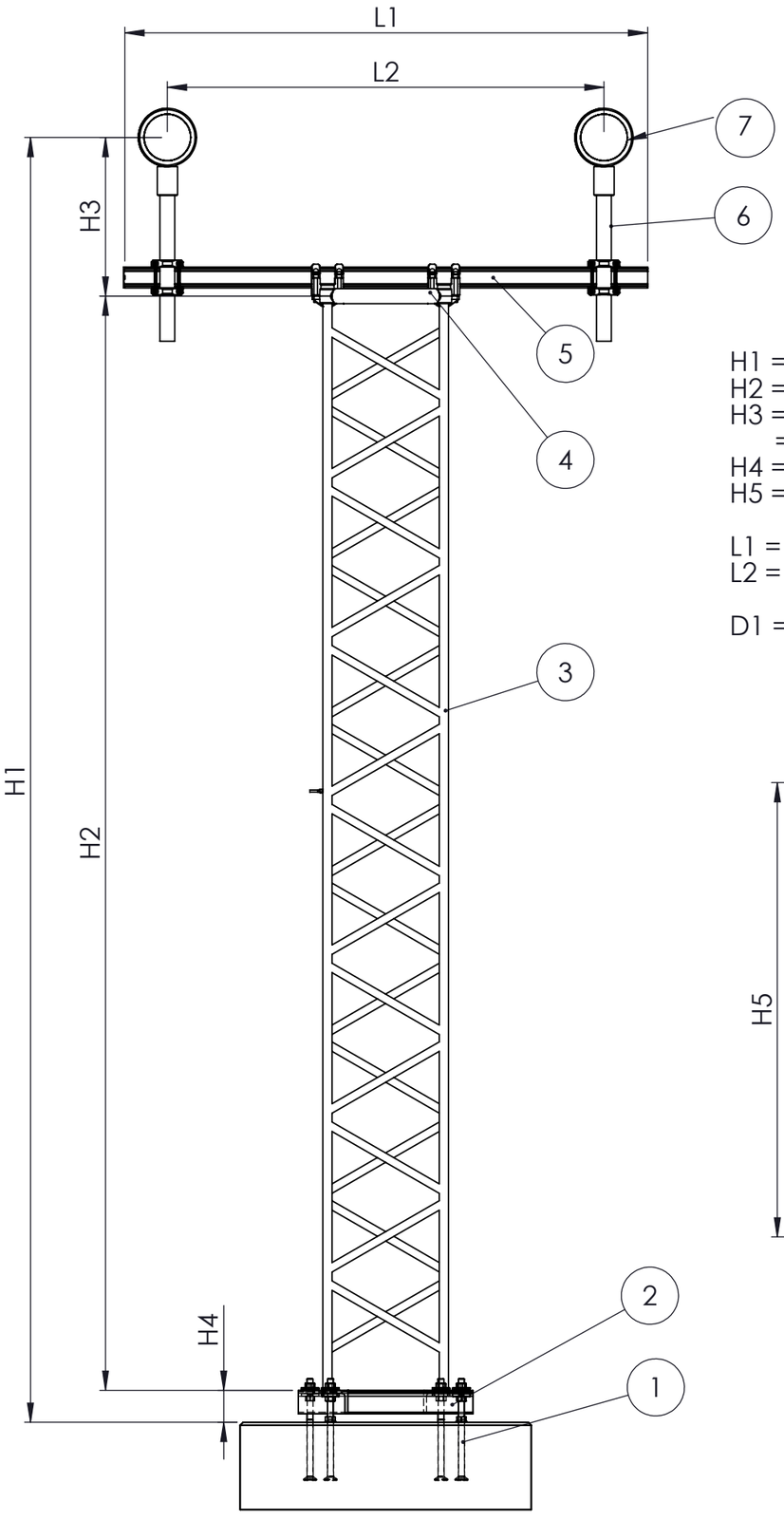
SCALE:1:25

SHEET 1 OF 1

4. maaliskuuta 2019 13:05:06

G:\KVA\Asiakirjat\Tuoteryhmat\Mastot\Dwg\641187-A

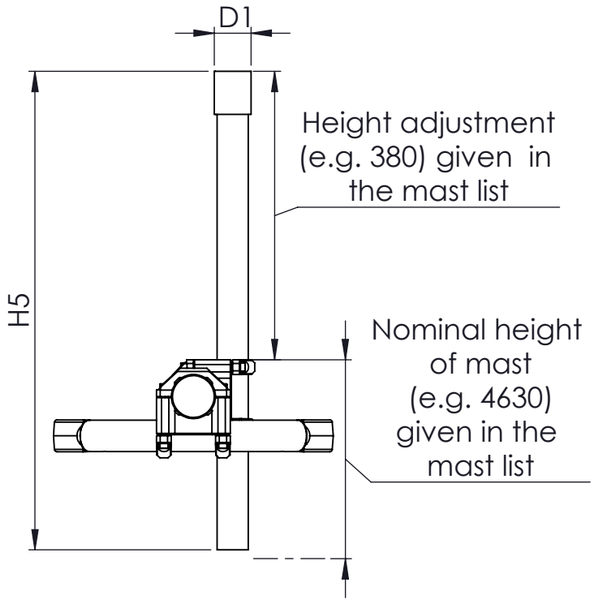
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L400 base Frame
3	Mast Module L400
4	Top Frame L400
5	Cross-bar tube
6	Light mounting
7	Light (Not included in delivery)
8	Wiring cover tubes (optional)
23	Hex. Socket Screw



H1 = Light height from base level
H2 = Height of L400 mast module
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of adjustment tube

L1 = Cross-bar tube lenght
L2 = Light spacing

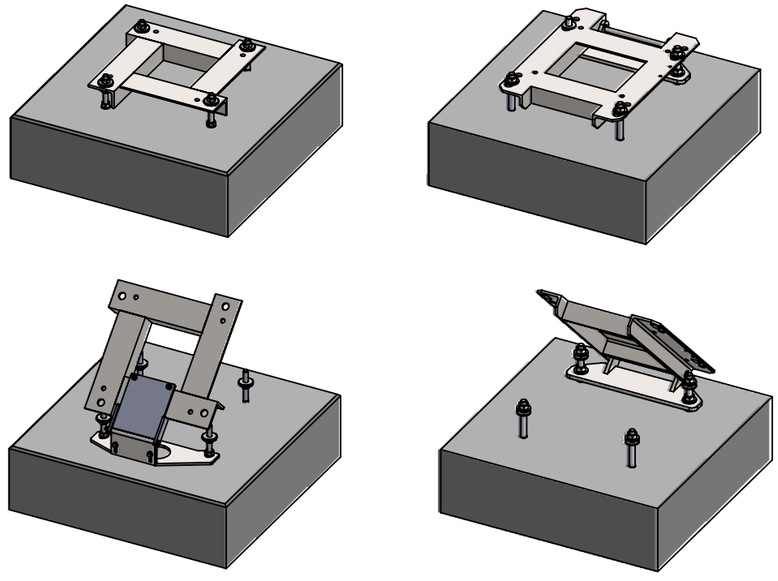
D1 = Diameter of light bracket



Base frames

L400 Fixed base frame
L400 with hingetool

L400 Hinged base frame



	NAME		DATE
DRAWN	MTa		4.3.2019
APPV'D			

TITLE: Approach lattice mast L400, 2 lights

PROJECT

DWG NO. 641009-A

A3

WEIGHT kg:

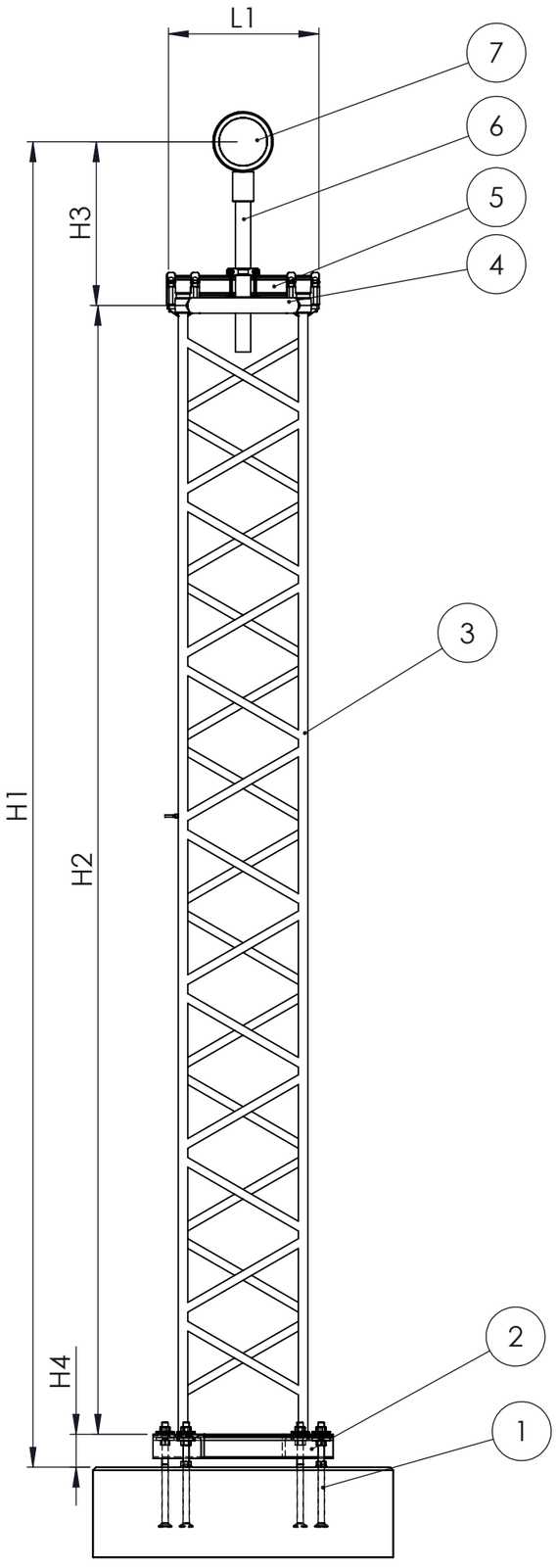
SCALE:1:20

SHEET 1 OF 1

4. maaliskuuta 2019 13:07:01

G:\KVA\Asiakirjat\Tuoteryhmat\Mastot\Dwg\641009-A

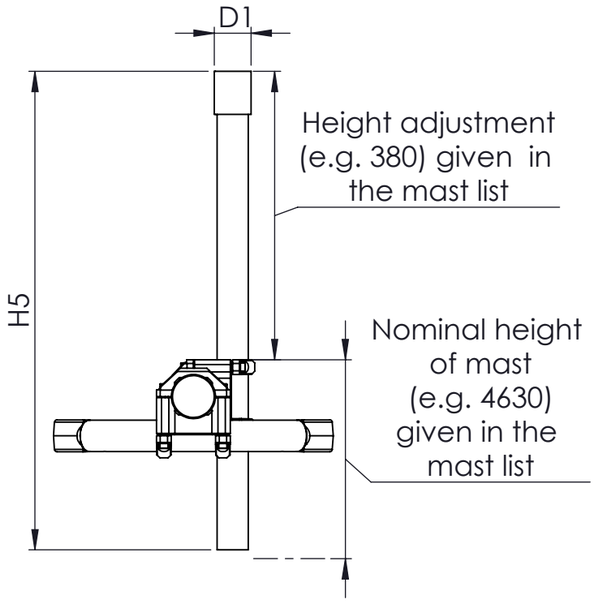
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L400 base Frame
3	Mast Module L400
4	Top Frame L400
5	Cross-bar tube
6	Light mounting
7	Light (Not included in delivery)
8	Wiring cover tubes (optional)



H1 = Light height from base level
H2 = Height of L400 mast module
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of adjustment tube

L1 = Cross-bar tube lenght

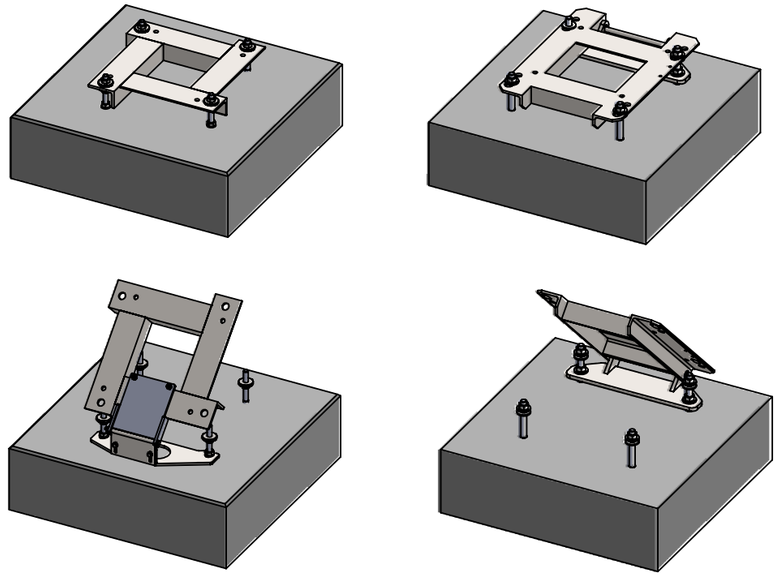
D1 = Diameter of light bracket



Base frames

L400 Fixed base frame
L400 with hingetool

L400 Hinged base frame



	NAME		DATE
DRAWN	MTa		4.3.2019
APPV'D			

TITLE: Approach Lattice mast L400, 1 light

PROJECT

DWG NO. 641010-A

A3

WEIGHT kg:

SCALE:1:20

SHEET 1 OF 1

4. maaliskuuta 2019 12:57:39

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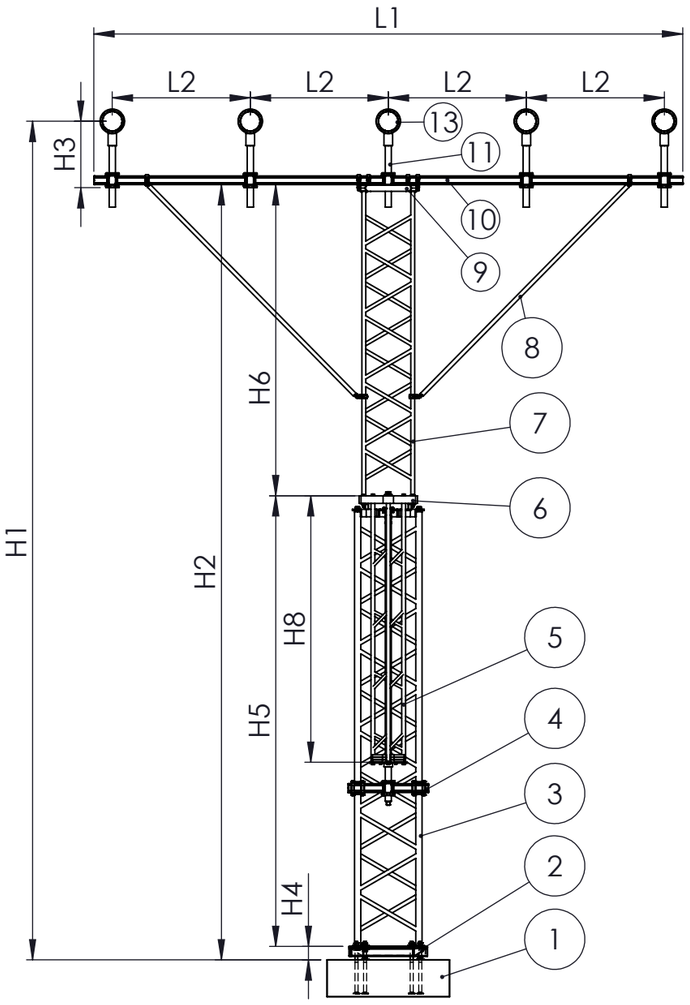
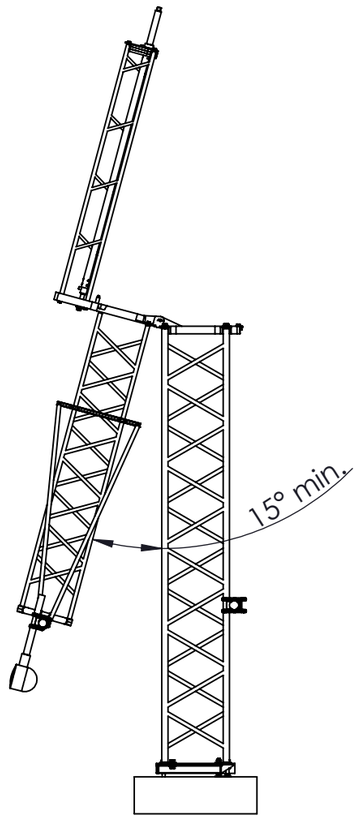
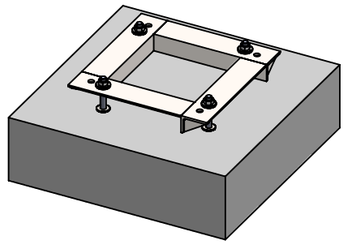




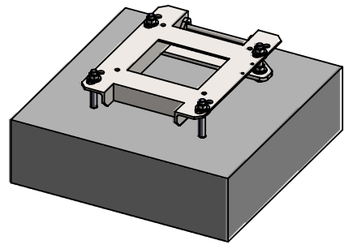
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L500 Base frame
3	MAST MODULE 500 ∅ 51
4	Clamping beam
5	Triangular Lever arm
6	Centrehinge assembly
7	MAST MODULE 400 ∅ 32
8	Strut arm assembly
9	Top Frame L400
10	Cross bar tube ∅72
11	Light mounting
12	Safety devices for tilting
13	Light (not included in delivery)
14	Wiring cover tubes (optional)

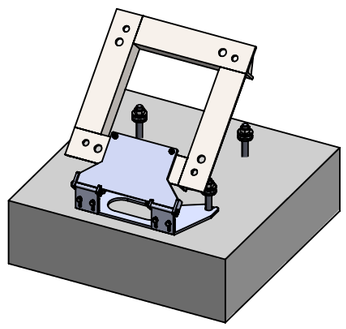
Base Frames

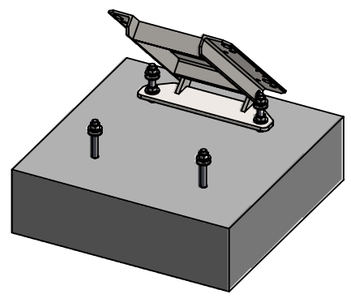
L500 fixed base frame
L500 with hingetool



L500 hinged base frame



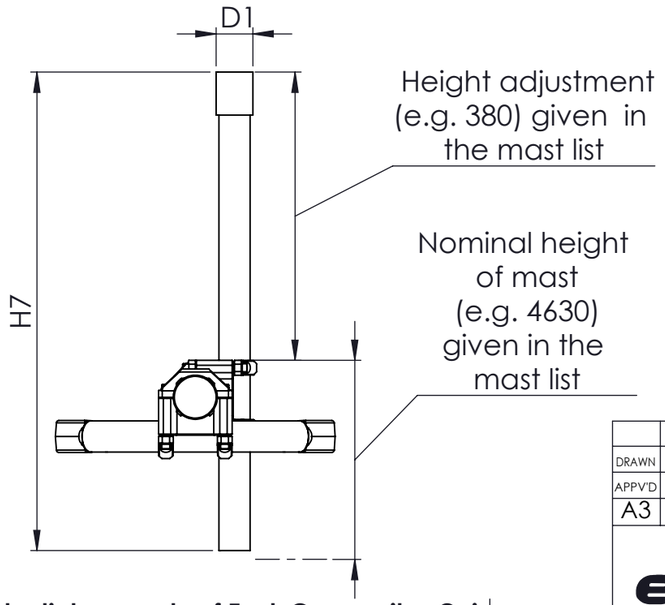




H1 = Light height from base level
H2 = Height of mast modules
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of L500 mast module
H6 = Height of L400 mast module
H7 = Height of adjustment tube
H8 = Height of triangular lever arm

L1 = Cross-bar tube lenght
L2 = Light spacing

D1 = Diameter of light bracket



	NAME		DATE
DRAWN	Taurainen Mikko		4.3.2019
APPV'D			
A3			

TITLE: **Centre hinged approach mast, 5 lights**

PROJECT

DWG NO. 643166A

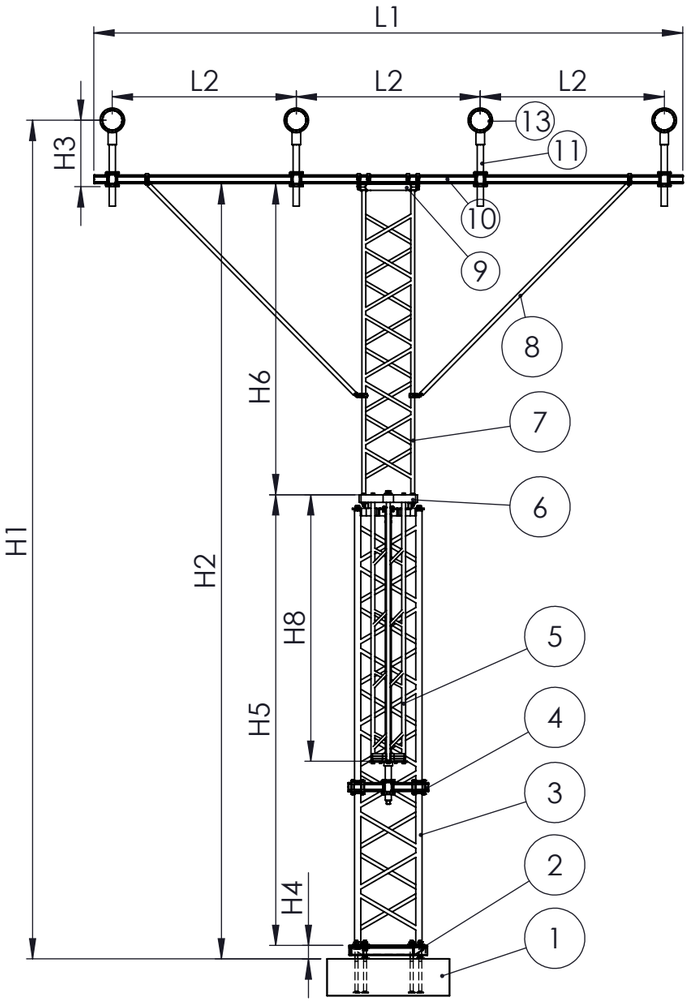
REVISION

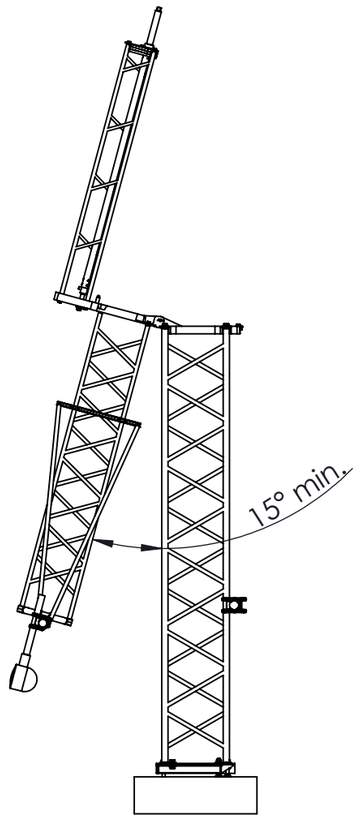
WEIGHT kg:

SCALE:1:50

SHEET 1 OF 1

4. maaliskuuta 2019 9:22:05



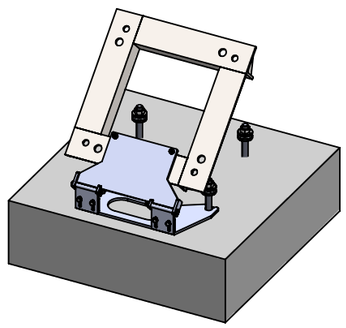


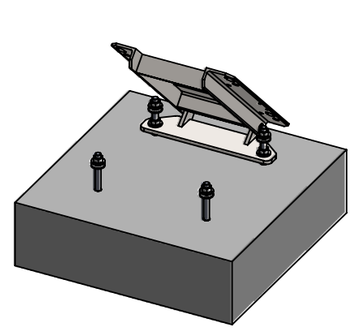
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L500 Base frame
3	MAST MODULE 500 ∅ 51
4	Clamping beam
5	Triangular Lever arm
6	Centrehinge assembly
7	MAST MODULE 400 ∅ 32
8	Strut arm assembly
9	Top Frame L400
10	Cross bar tube ∅72
11	Light mounting
12	Safety devices for tilting
13	Light (not included in delivery)
14	Wiring cover tubes (optional)

Base Frames

L500 fixed base frame
L500 with hingetool

L500 hinged base frame

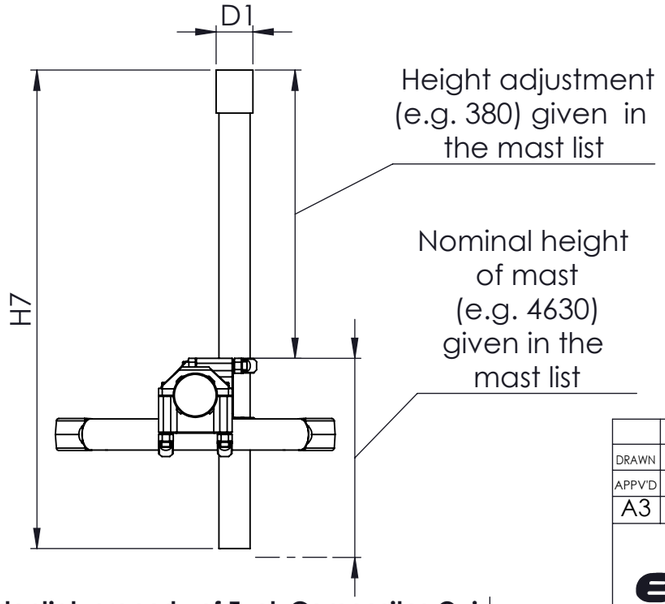




H1 = Light height from base level
H2 = Height of mast modules
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of L500 mast module
H6 = Height of L400 mast module
H7 = Height of adjustment tube
H8 = Height of triangular lever arm

L1 = Cross-bar tube lenght
L2 = Light spacing

D1 = Diameter of light bracket



	NAME		DATE
DRAWN	Taurainen Mikko		4.3.2019
APPV'D			
A3			

TITLE: **Centre hinged approach mast, 4 lights**

PROJECT

DWG NO. 643167A

REVISION

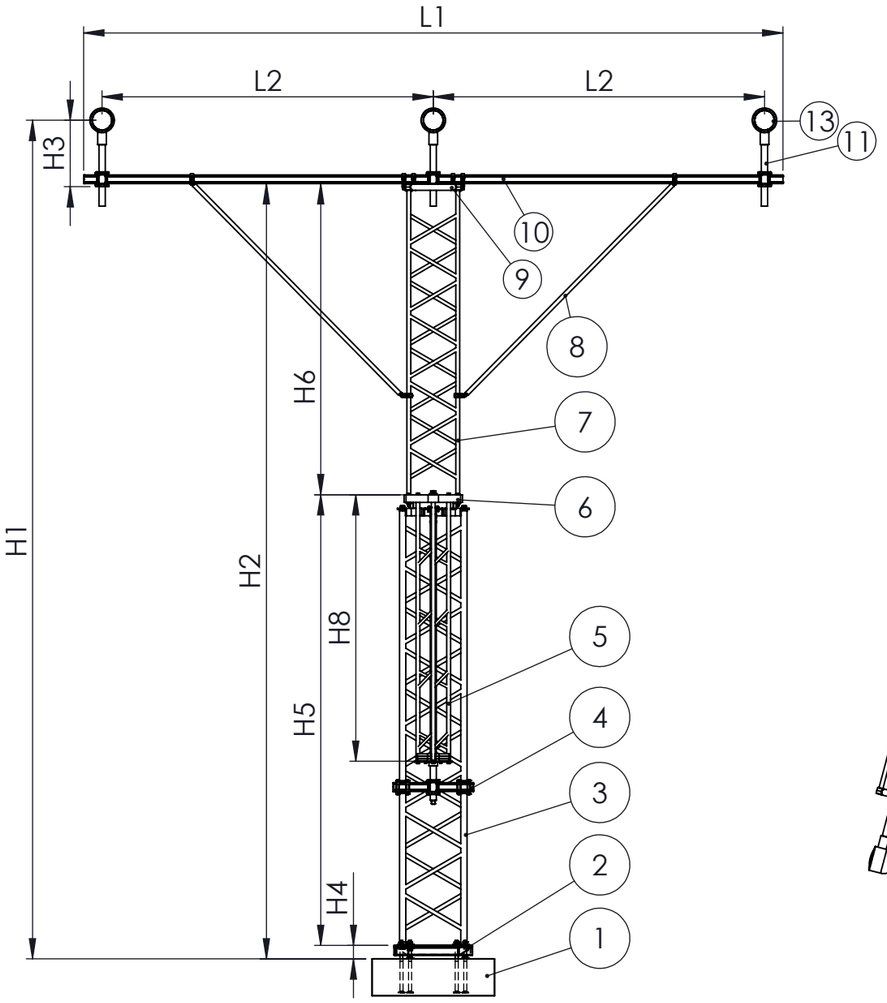
WEIGHT kg:

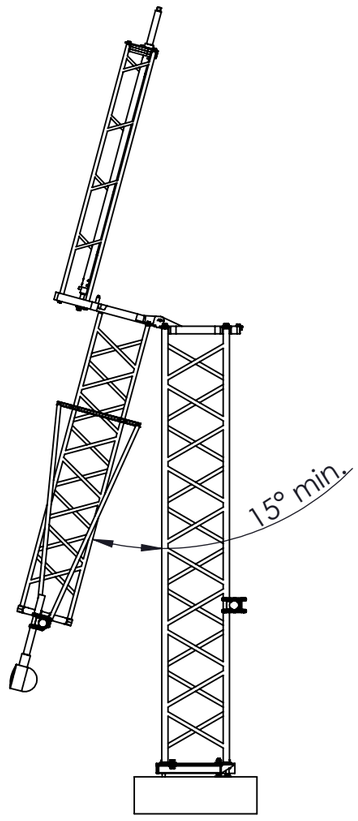
SCALE:1:50

SHEET 1 OF 1

4. maaliskuuta 2019 9:19:40

ITEM NO.	DESCRIPTION
1	Foundation parts
2	L500 Base frame
3	MAST MODULE 500 ∅ 51
4	Clamping beam
5	Triangular Lever arm
6	Centrehinge assembly
7	MAST MODULE 400 ∅ 32
8	Strut arm assembly
9	Top Frame L400
10	Cross bar tube ∅72
11	Light mounting
12	Safety devices for tilting
13	Light (not included in delivery)
14	Wiring cover tubes (optional)

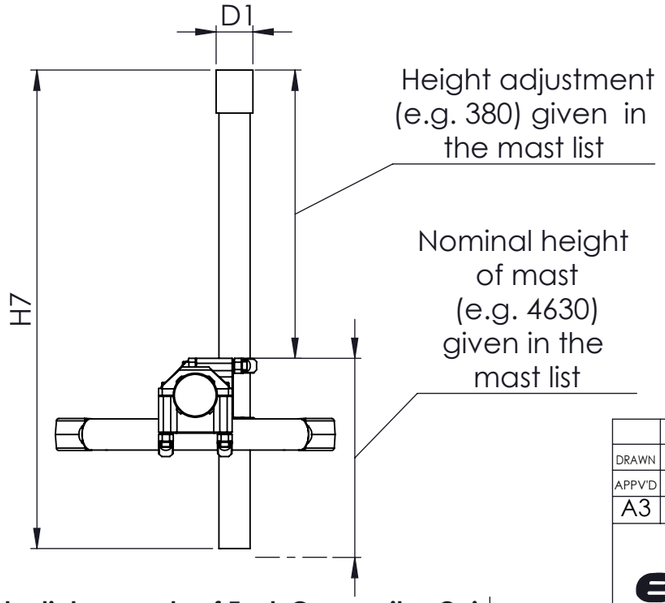




H1 = Light height from base level
H2 = Height of mast modules
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of L500 mast module
H6 = Height of L400 mast module
H7 = Height of adjustment tube
H8 = Height of triangular lever arm

L1 = Cross-bar tube lenght
L2 = Light spacing

D1 = Diameter of light bracket



Base Frames

L500 fixed base frame
L500 with hingetool

L500 hinged base frame

	NAME		DATE
DRAWN	Taurainen Mikko		4.3.2019
APPV'D			
A3			

TITLE: **Centre hinged approach mast, 3 lights**

PROJECT

DWG NO. 643168A

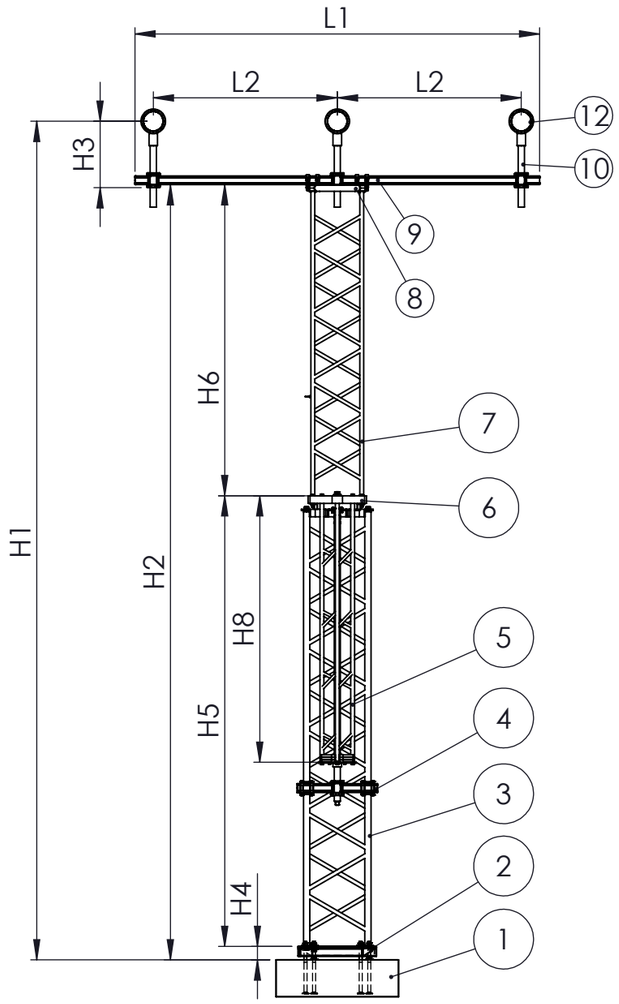
REVISION

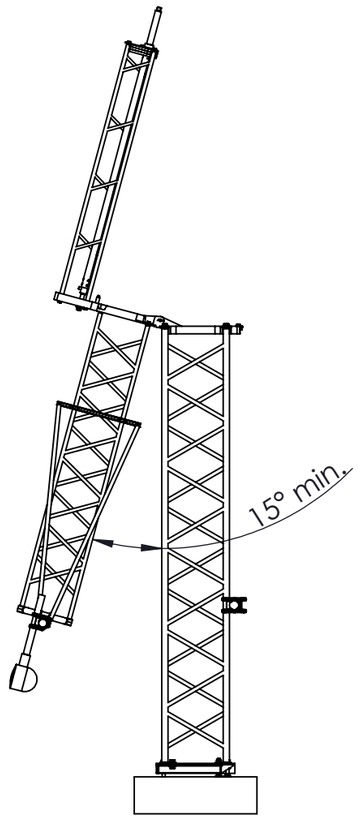
WEIGHT kg:

SCALE:1:50

SHEET 1 OF 1

4. maaliskuuta 2019 9:15:06

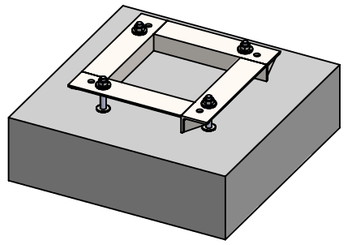




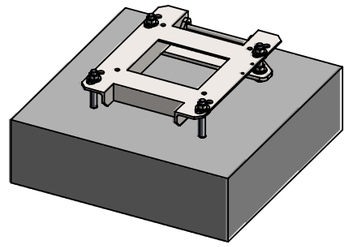
ITEM NO.	DESCRIPTION
1	Foundation parts
2	L500 Base frame
3	MAST MODULE 500 ∅ 51
4	Clamping beam
5	Triangular Lever arm
6	Centrehinge assembly
7	MAST MODULE 400 ∅ 32
8	Top Frame L400
9	Cross bar tube ∅72
10	Light mounting
11	Safety devices for tilting
12	Light (not included in delivery)
13	Wiring cover tubes (optional)

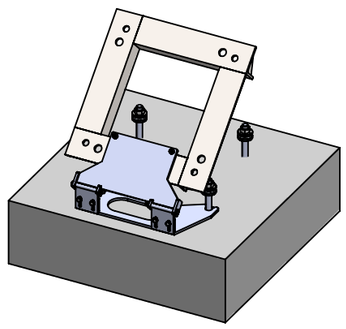
Base Frames

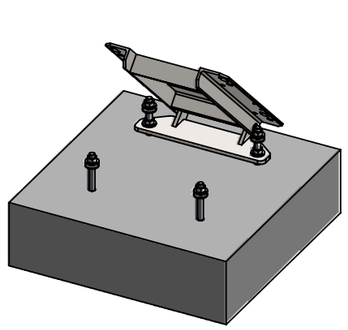
L500 fixed base frame
L500 with hingetool



L500 hinged base frame



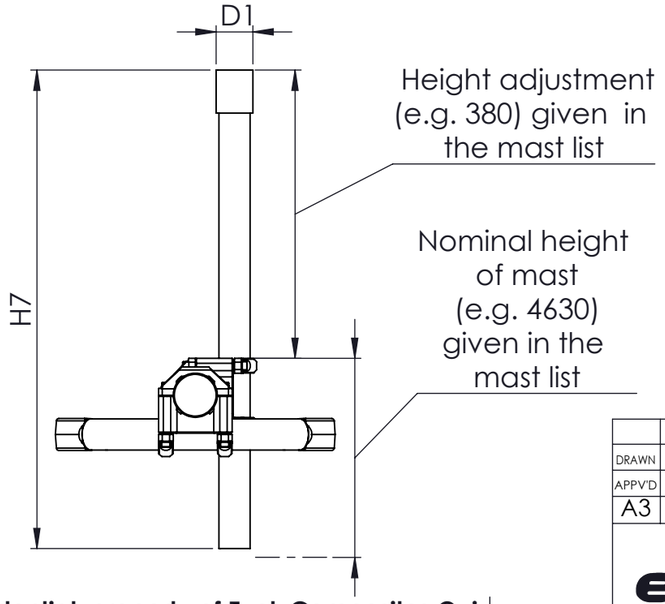




H1 = Light height from base level
H2 = Height of mast modules
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of L500 mast module
H6 = Height of L400 mast module
H7 = Height of adjustment tube
H8 = Height of triangular lever arm

L1 = Cross-bar tube lenght
L2 = Light spacing

D1 = Diameter of light bracket



	NAME		DATE
DRAWN	Taurainen Mikko		4.3.2019
APPV'D			
A3			

TITLE: **Centre hinged approach mast, 3 lights**

PROJECT

DWG NO. 643169A

REVISION

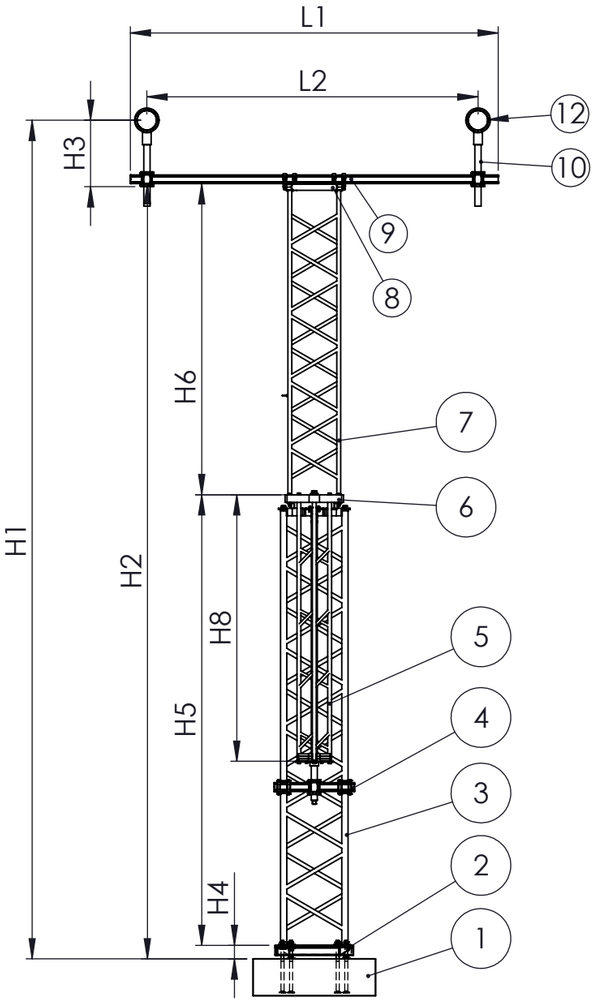
WEIGHT kg:

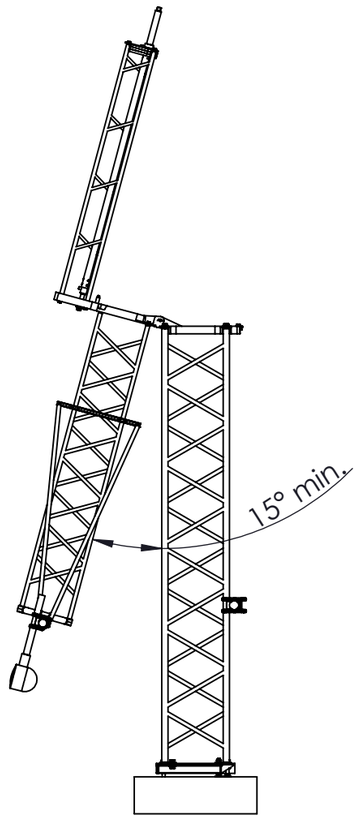
SCALE:1:50

SHEET 1 OF 1

4. maaliskuuta 2019 9:07:52

ITEM NO.	DESCRIPTION
1	Foundation parts
2	L500 Base frame
3	MAST MODULE 500 ∅ 51
4	Clamping beam
5	Triangular Lever arm
6	Centrehinge assembly
7	MAST MODULE 400 ∅ 32
8	Top Frame L400
9	Cross bar tube ∅72
10	Light mounting
11	Safety devices for tilting
12	Light (not included in delivery)
13	Wiring cover tubes (optional)

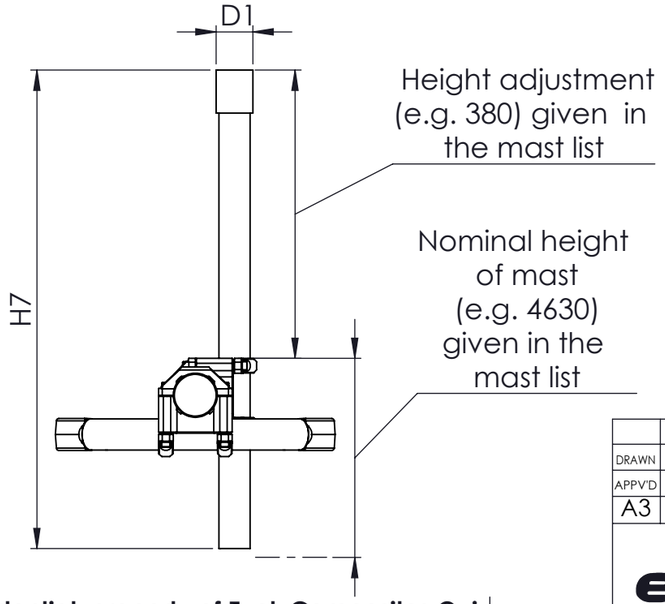




H1 = Light height from base level
H2 = Height of mast modules
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of L500 mast module
H6 = Height of L400 mast module
H7 = Height of adjustment tube
H8 = Height of triangular lever arm

L1 = Cross-bar tube lenght
L2 = Light spacing

D1 = Diameter of light bracket



Base Frames

L500 fixed base frame
L500 with hingetool

L500 hinged base frame

	NAME		DATE
DRAWN	Taurainen Mikko		1.3.2019
APPV'D			
A3			

TITLE: **Centre hinged approach mast, 2 lights**

PROJECT

DWG NO. 643170A

REVISION

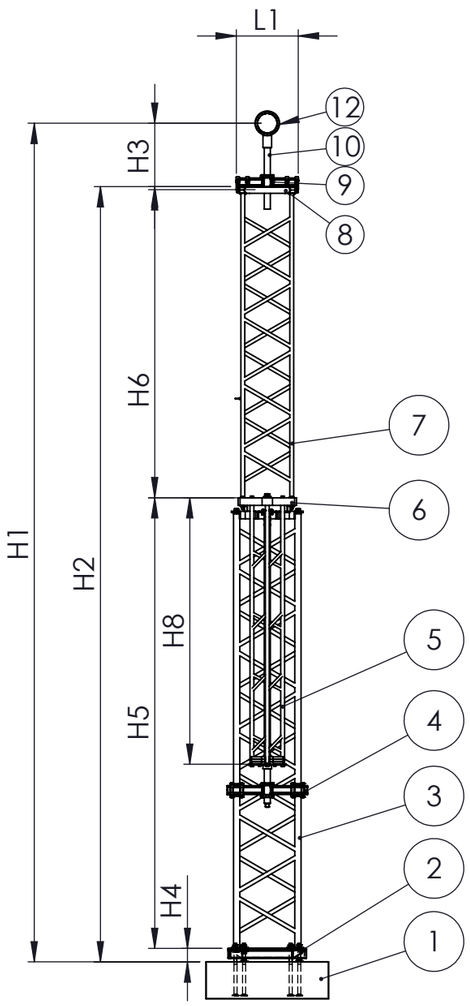
WEIGHT kg:

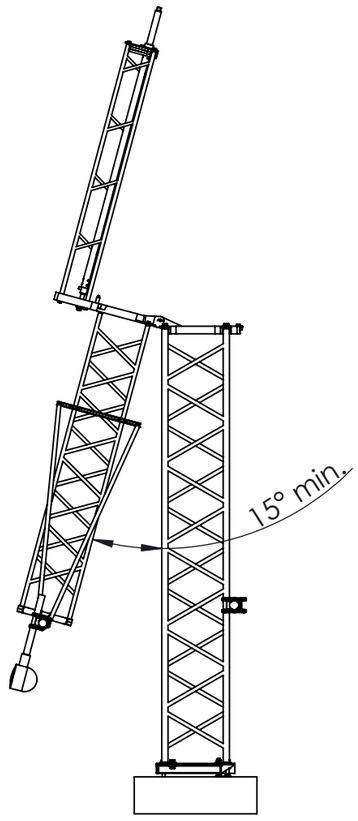
SCALE:1:50

SHEET 1 OF 1

1. maaliskuuta 2019 18:34:55

ITEM NO.	DESCRIPTION
1	Foundation parts
2	L500 Base frame
3	MAST MODULE 500 ∅ 51
4	Clamping beam
5	Triangular Lever arm
6	Centrehinge assembly
7	MAST MODULE 400 ∅ 32
8	Top Frame L400
9	Cross bar tube ∅72
10	Light mounting
11	Safety devices for tilting
12	Light (not included in delivery)
13	Wiring cover tubes (optional)

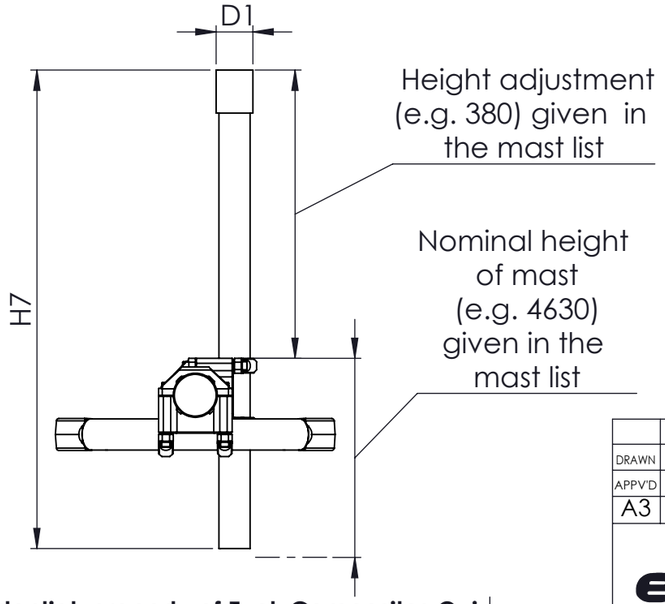




H1 = Light height from base level
H2 = Height of mast modules
H3 = Light height from the L400 mast module
= Light height adjustment ± 250 mm
H4 = Height of base frame upper surface from base level
H5 = Height of L500 mast module
H6 = Height of L400 mast module
H7 = Height of adjustment tube
H8 = Height of triangular lever arm

L1 = Cross-bar tube lenght
L2 = Light spacing

D1 = Diameter of light bracket



Base Frames

L500 fixed base frame
L500 with hingetool

L500 hinged base frame

	NAME		DATE
DRAWN	Taurainen Mikko		1.3.2019
APPV'D			
A3			

TITLE: **Centre hinged approach mast, 1 light**

PROJECT

DWG NO. 643171A

REVISION

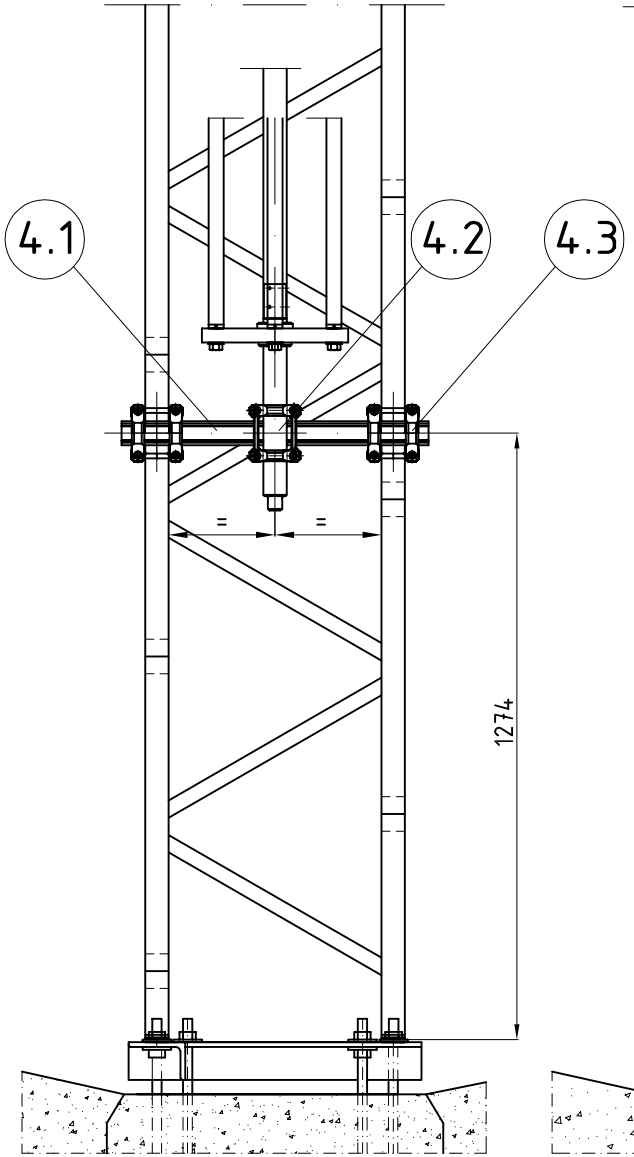
WEIGHT kg:

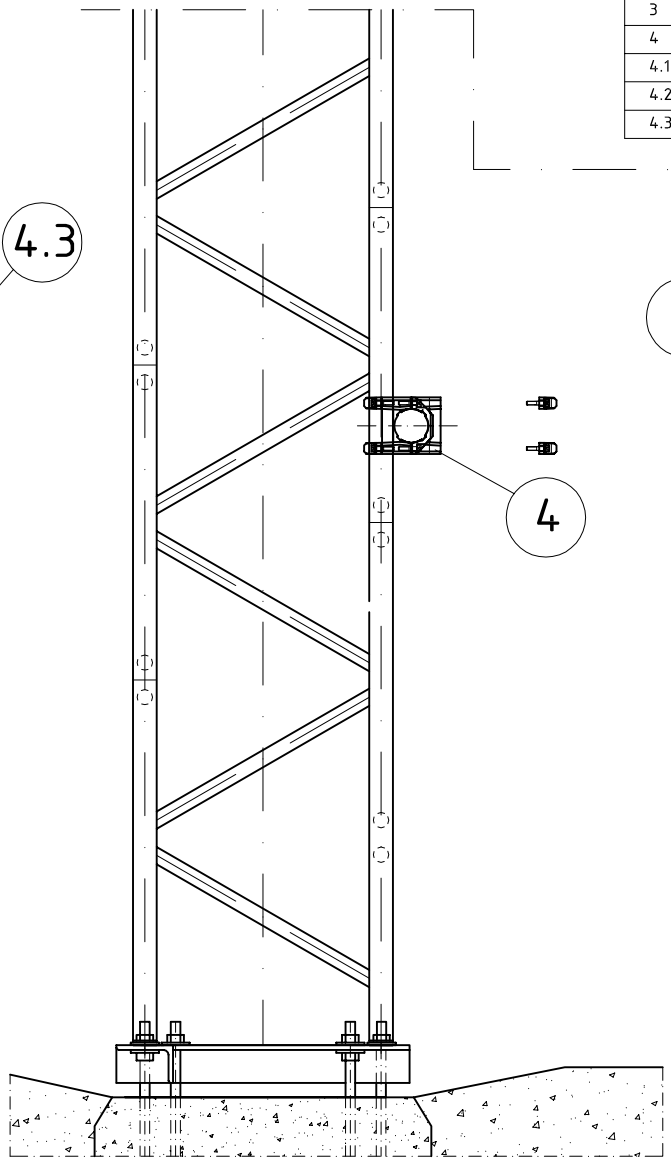
SCALE:1:50

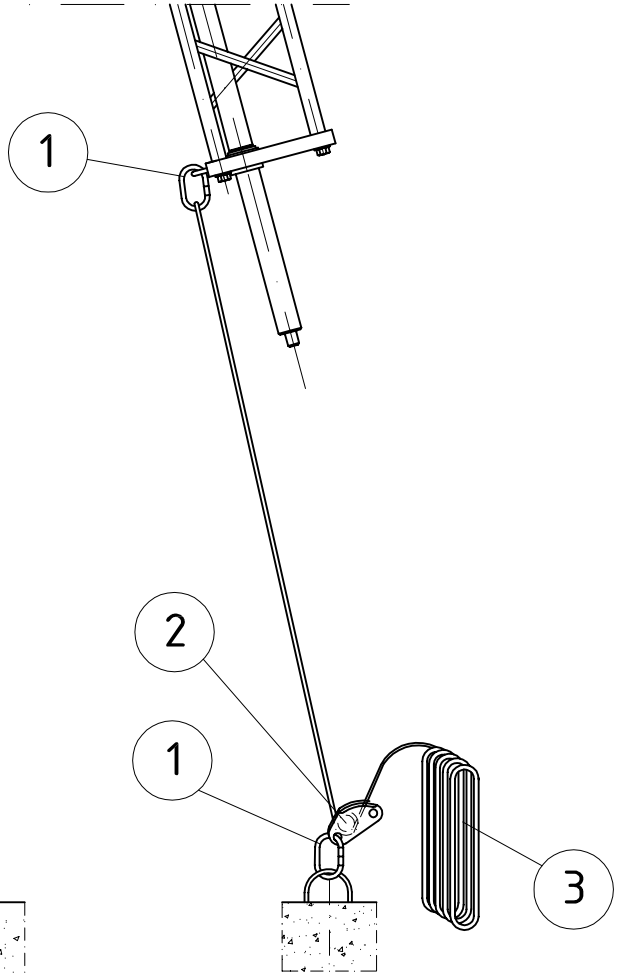
SHEET 1 OF 1

1. maaliskuuta 2019 15:37:52

Item	Qty	Name	Shape, dim., drw. no.	Material	Weight
1	2	ROPE CLAMP	OK- M70		
2	1	SAFETY CATCH	D 14 GRIGRI		
3	1	ROPE	~ 20m	NYLON	
4	1	CLAMPING BEAM			
4.1	1	X-BAR TUBE L=650	641174		
4.2	1	X-BAR TUBE CLAMP	641184		
4.3	2	X-BAR TUBE CLAMP	641184(D51) / 642214(D53)		







Rev.	Date	Information	Design.
A	3.1.2006	US MEASUREMENTS ADDED	JAJ

Project

Reference

Scale 1:20

Title

CENTRE HINGED MAST

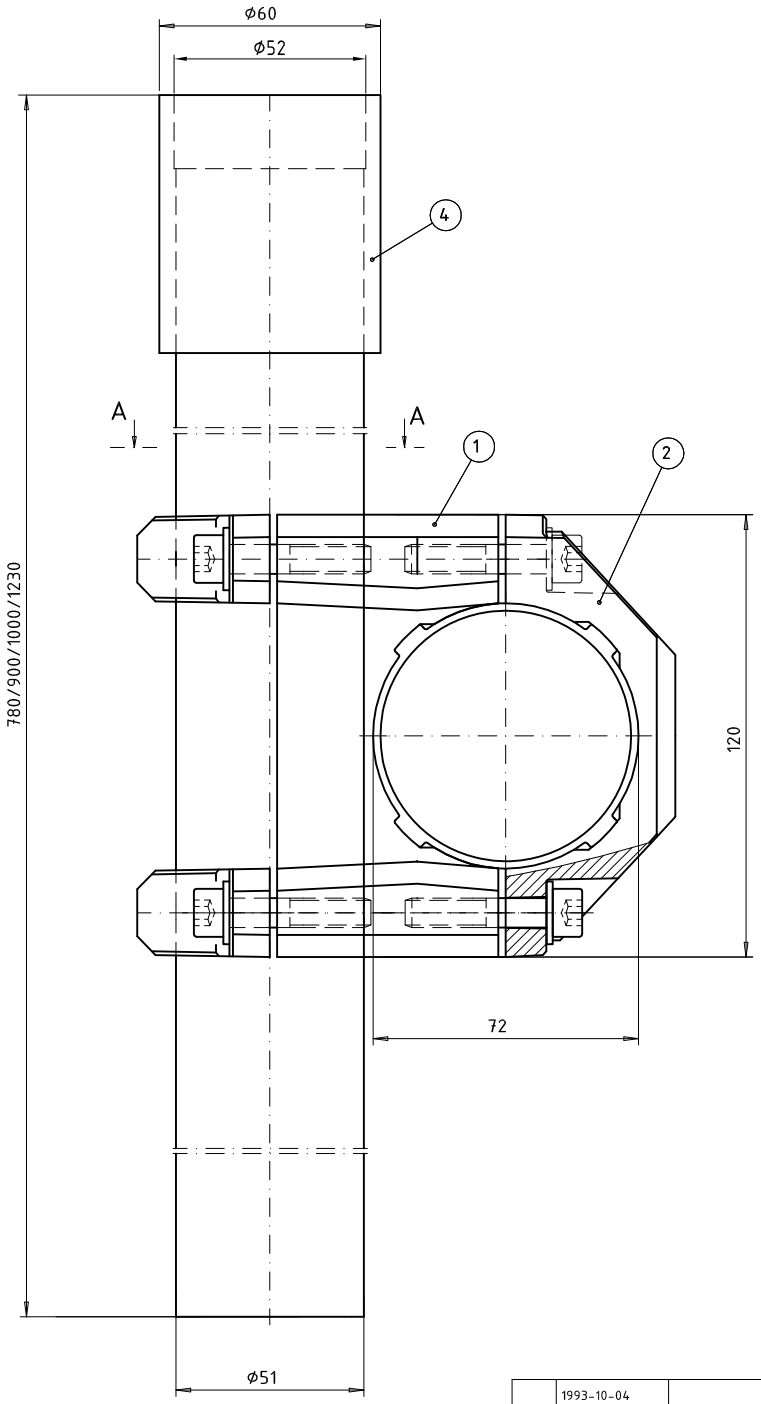
SAFETY DEVICES FOR TILTING

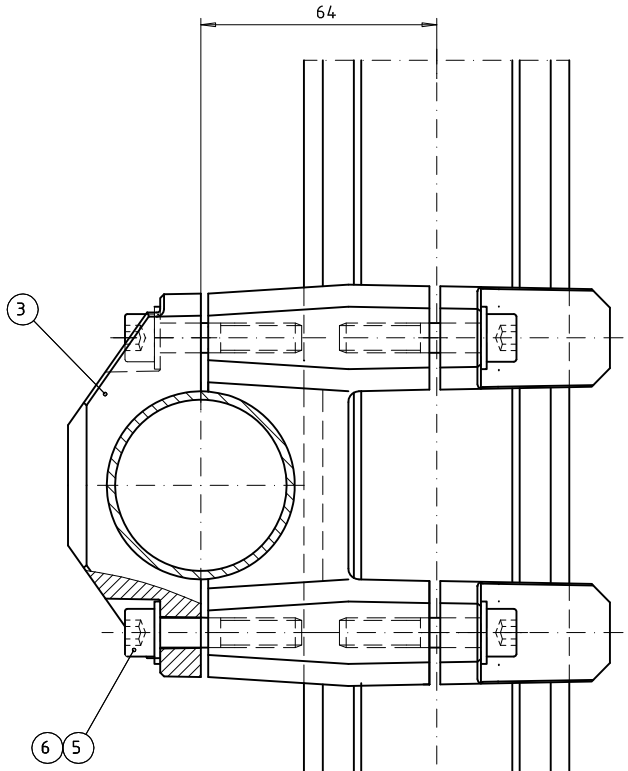
CLAMPING BEAM OF LOCKING ARM

KIVARA FACTORY
MUOVILAAKSONTIE 2
FIN-82110 HEINÄVAARA

Drw. no. 641975A

Item	Qty	Name	Shape, dim., drw. no.	Material	Weight
1	1	CLAMP FRAME	641160		
2	2	CROSSBOW ø72	641164		
3	2	CROSSBOW ø51	641165		
4	1	HEIGHT ADJUSTMENT TUBE	641172A		
5	8	ALLEN SCREW M8x35	DIN 912	A4	
6	8	WASHER M8	DIN 125	A4	





A---A

Rev.	Date	Information	Design.
	1993-10-04		Epn

Project

Reference

Scale 1:1

Title

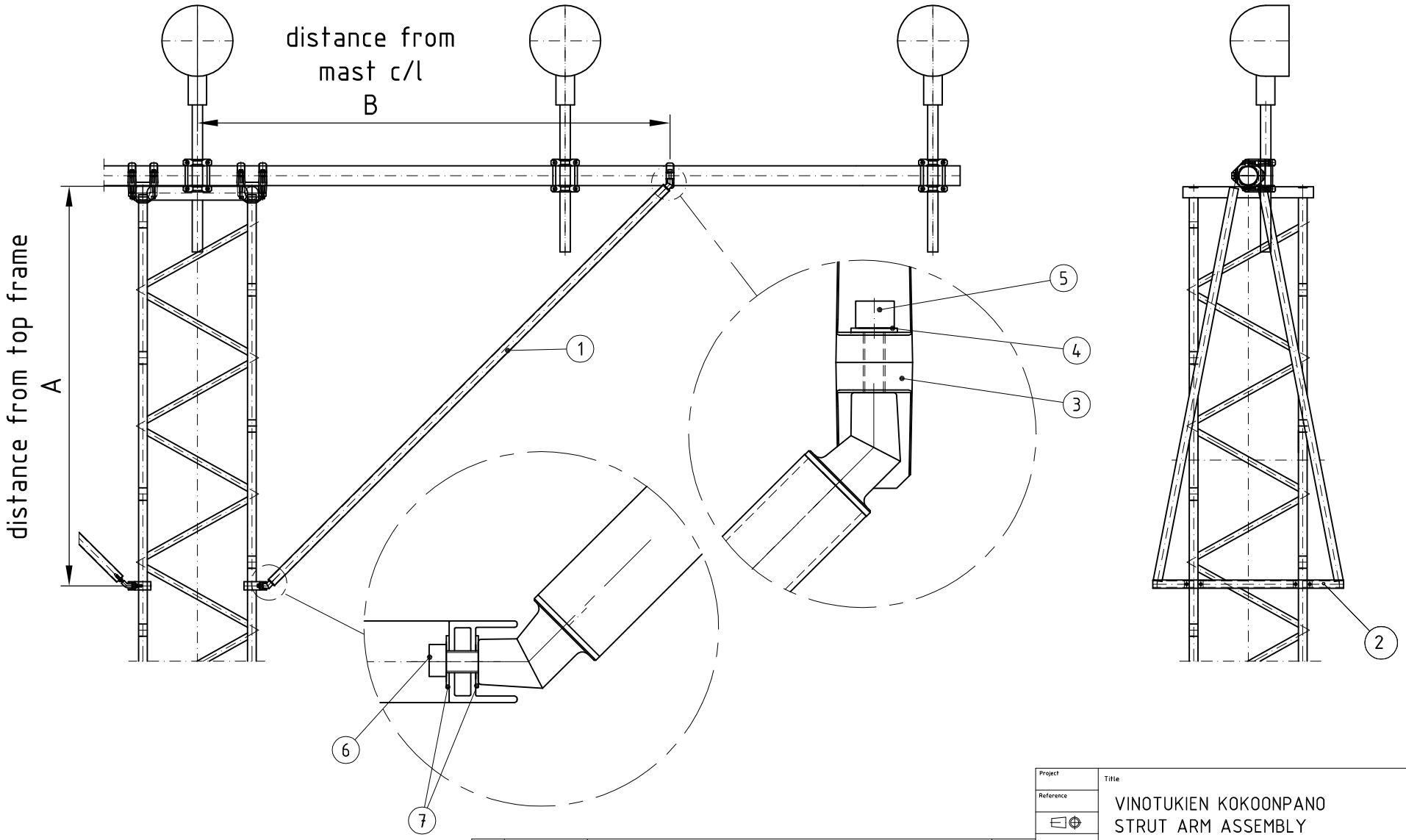
SÄÄTÖPUTKI JA KIINNIKE
ADJUSTMENT TUBE AND CLAMP

exel composites
KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

Drw. no.
641171

LENGTH OF STRUT ARM (PART NO. 1)	A	B
1400 mm	965	1230
1900 mm	1320	1580
2200 mm	1530	1800
2500 mm	1740	2010

Item	Qty	Name	Shape, dim., drw. no.	Material	Weight
1	4	strut arm tube	641198A		
2	2	Horizontal support	641179		
3	4	Clamp Ø72	641164	NEPOL	
4	4	Washer	Ø15.5/8.3x1.5	A4	
5	4	Allen screw M8x45	DIN 912	A4	
6	4	Allen screw M8x35	DIN 912	A4	
7	8	Bonded washer	Ø19/8.3x4	A4	



Rev.	Date	Information	Design.
A	2011-10-04	Asennusmitat lisätty; installation dimensions added	JMA

Project

Reference

Scale
1:10

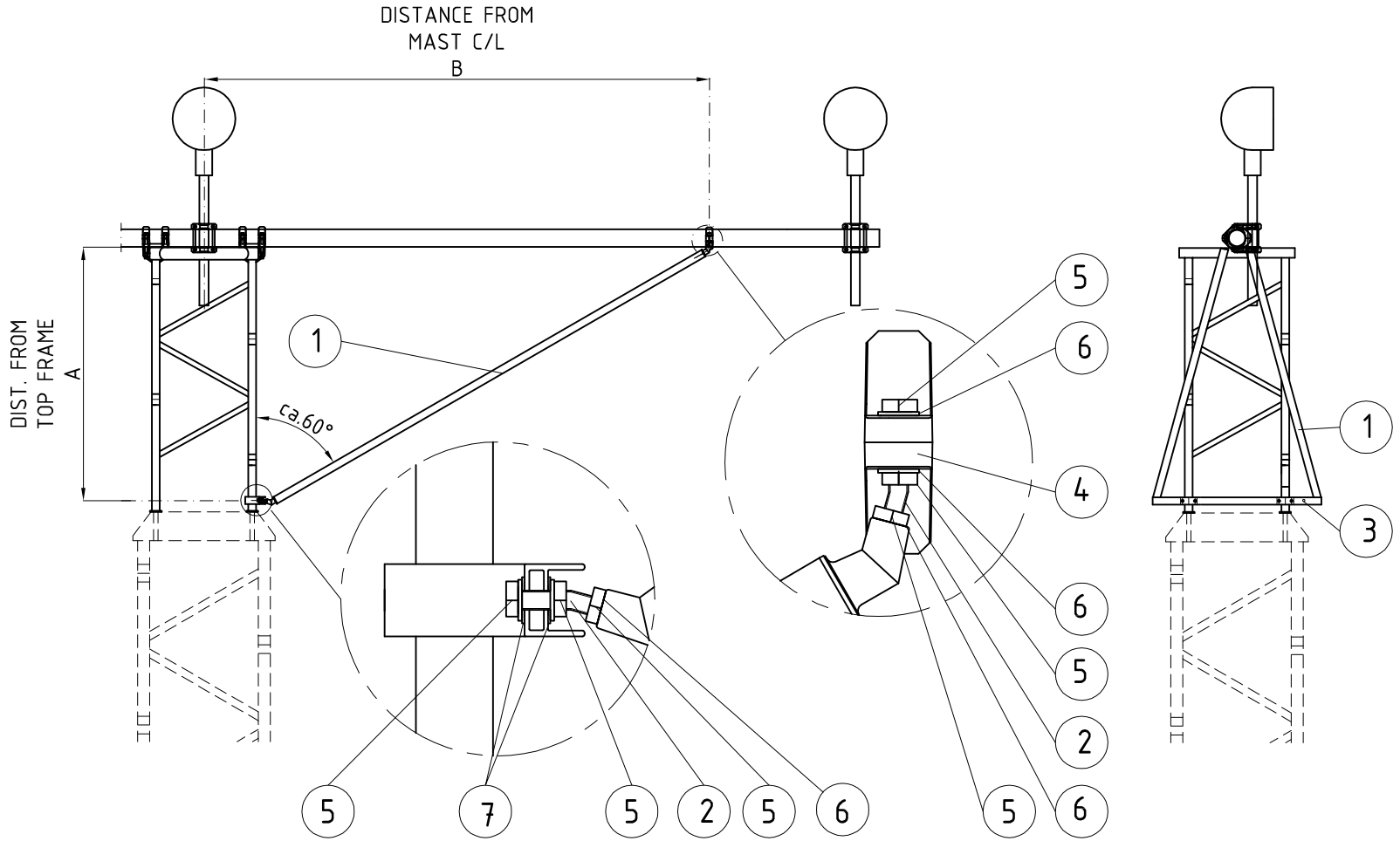
Title
VINOTUKIEN KOKOONPANO
STRUT ARM ASSEMBLY

KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

Drw. no.
641199A

LENGTH OF STRUT ARM (PART NO. 1)	A	B
990 mm	500	855
1400 mm	710	1430
1900 mm	960	1860
2200 mm	1070	2140

Item	Qty	Name	Shape, dim., drw. no.	Material	Weight
1	4	STRUT ARM TUBE	641198A		
2	8	ANGLE SCREW	641906		
3	2	HORIZONTAL SUPPORT	641179	NEPOL	
4	4	CROSS BOW ø72	641908	NEPOL	
5	24	HEX NUT	M8	A4	
6	16	WASHER	ø15.5/8.3x1.5	A4	
7	8	RUBBER BONDED WASHER	ø19/8.3x4	A4	



Rev.	Date	Information	Design.
C	2015-01-21	Strut arm L=990 added	JsK

Project

Reference

Scale 1:10

Title

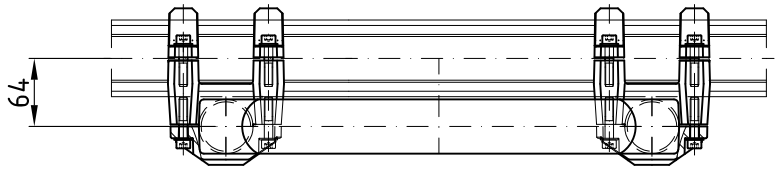
STRUT ARM ASSEMBLY
IN A SHORT MAST

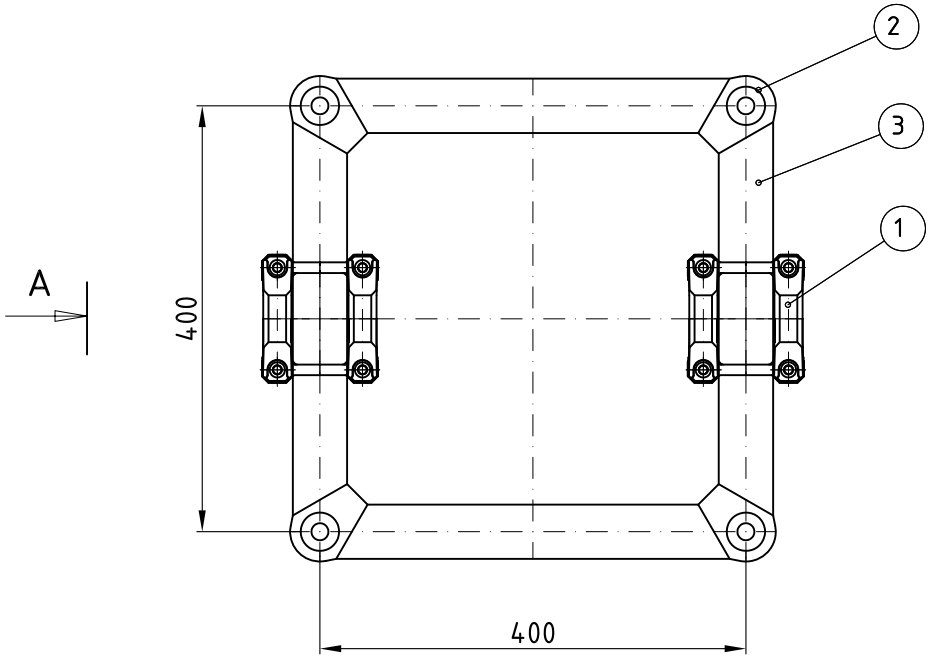
exel composites
KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

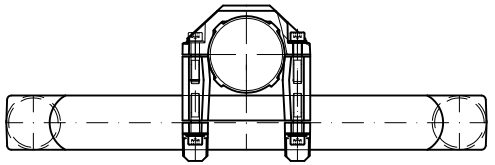
Drw. no.

641907C

Item	Qty	Name	Shape, dim., drw. no.	Material	Weight
1	2	CROSS-BAR TUBE CLAMP	641184		
2	4	CORNER PIECE	641185C		
3	4	TUBE ø51/46	641186A		







VIEW A

	1993-10-06		EPn
Rev.	Date	Information	Design.

Project	
Reference	
Scale	1:5

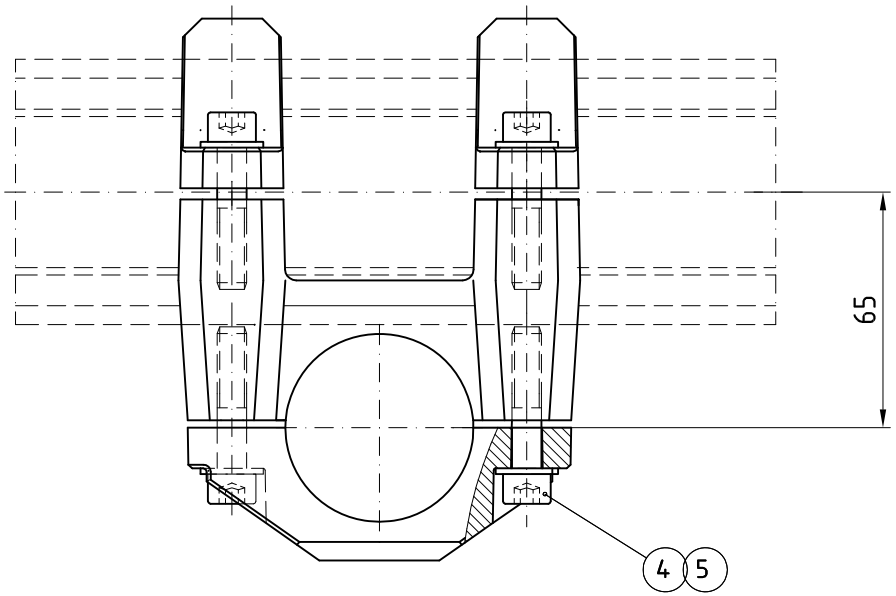
Title

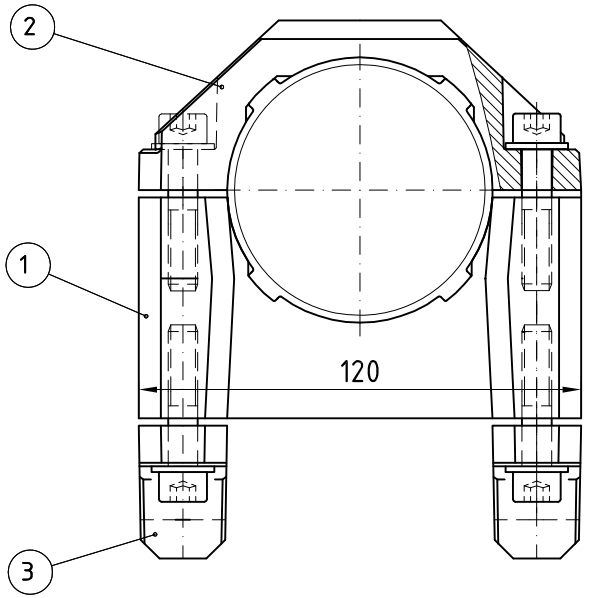
TOP FRAME

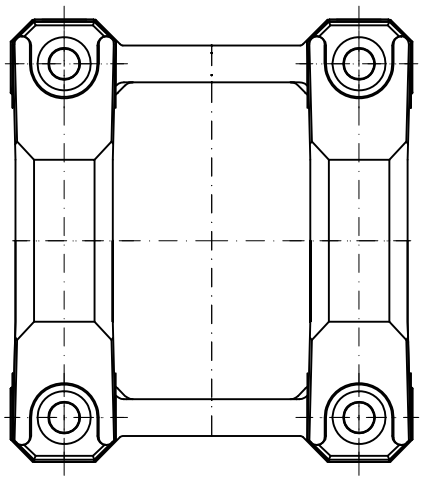
exel COMPOSITES
KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

Drw. no.
641183

Item	Qty	Name	Shape, dim., drw. no.	Material	Weight
1	1	CLAMP FRAME	641160		
2	2	CROSS BOW Φ72	641164		
3	2	CROSS BOW Φ51	641165		
4	8	ALLEN SCREW M8x35	DIN 912	A4	
5	8	WASHER M8	DIN 125	A4	







Rev.	Date	Information	Design.
	1993-10-06		EPn

Project

Reference
641171

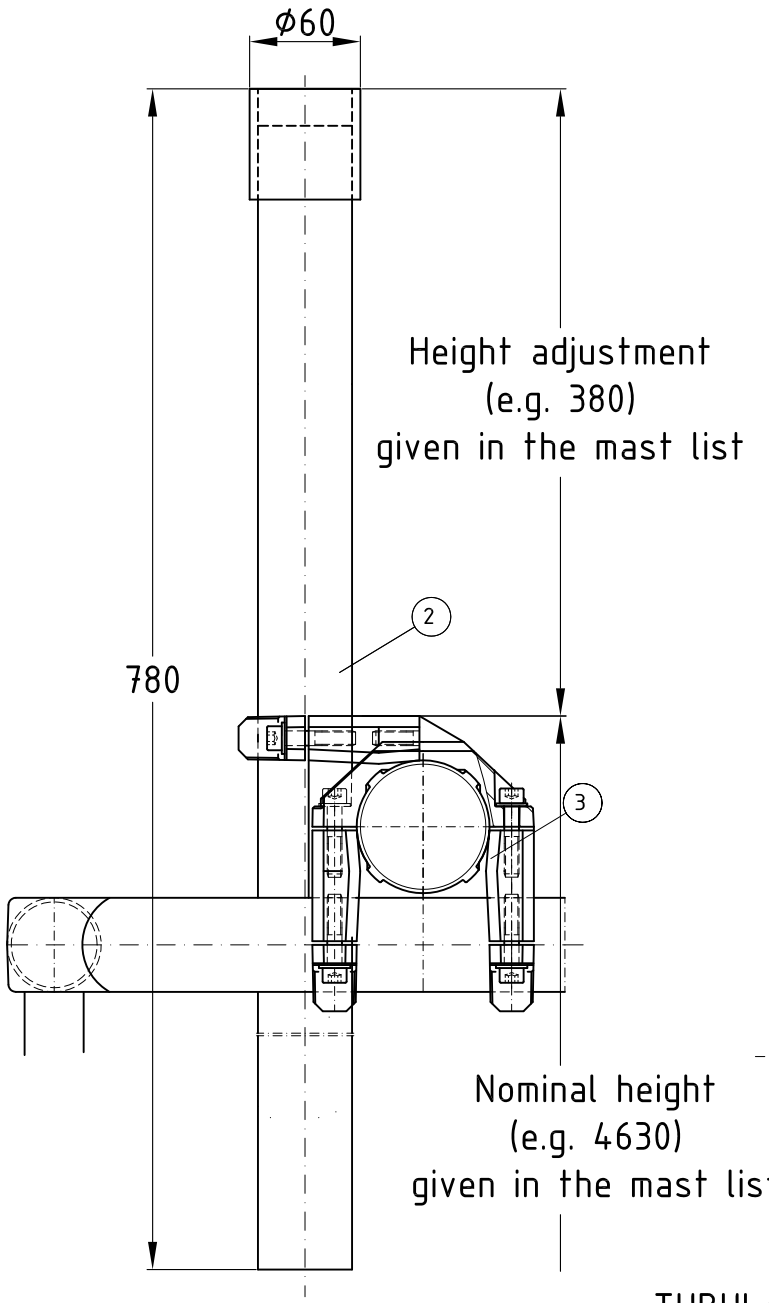
Scale
1:1

Title
SÄÄTÖPUTKEN KIINNIKE
ADJUSTMENT TUBE CLAMP

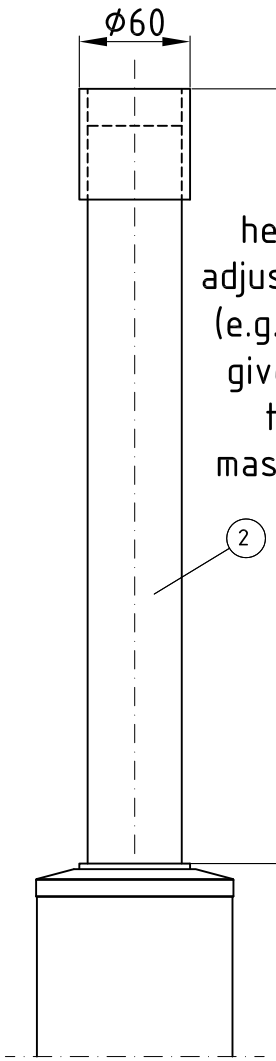
KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

Drw. no.
641184

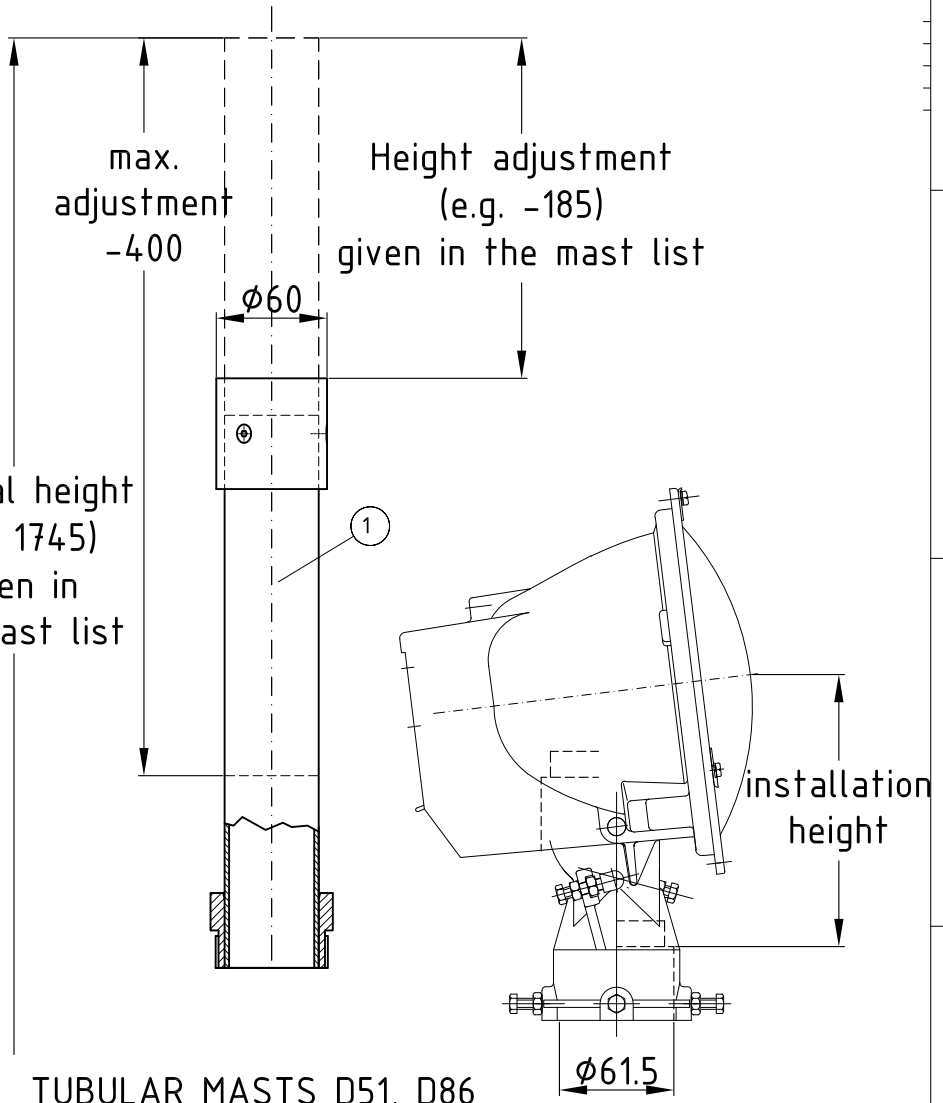
Item	Qty	Name	Shape, dim., drw. no.	Material	Weight
1	1	ADJUSTMENT TUBE D51	640822H		
2	1	ADJUSTMENT TUBE L=780	641172A		
3	1	ADJUSTMENT TUBE CLAMP ASS'Y	641184		



LATTICE MASTS L400, L500



TUBULAR MASTS D86L, D106L



TUBULAR MASTS D51, D86

Rev.	Date	Information	Design.
1	15.10.2003		JMa

Project

Reference

Scale 1:1

Title

ADJUSTMENT OF LIGHT HEIGHT
TUBULAR MASTS D51, D86(L), D106L
LATTICE MASTS L400, L500

EXEL COMPOSITES
KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

Drw. no.
642074